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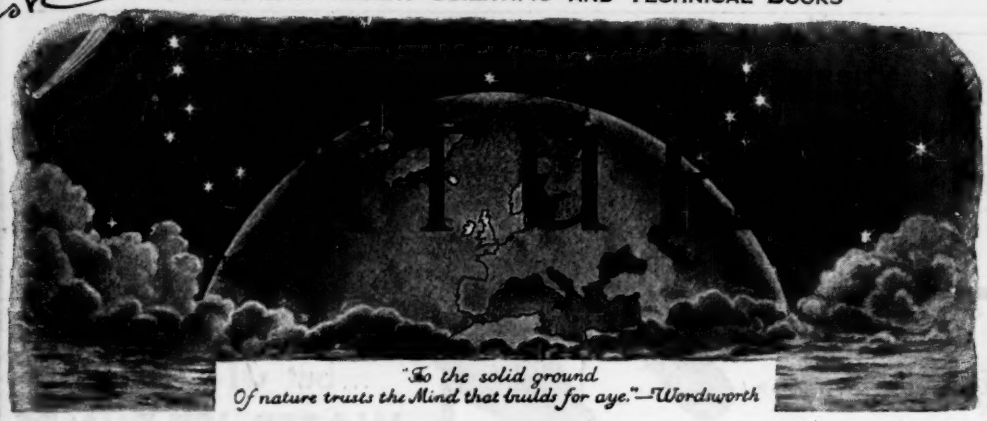

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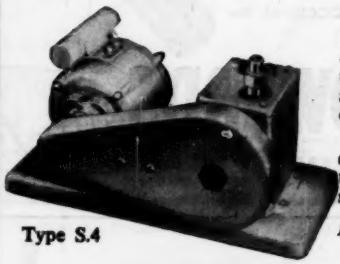

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NATURE

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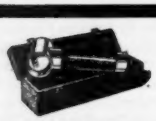
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SCIENCE AND RESPONSIBILITY

THE Government's decision to undertake the manufacture of thermonuclear weapons, although now generally accepted by the major political parties, has clearly been accepted with reluctance; and even from the point of view of defence there have been misgivings as to whether all the implications have been fully considered, and whether Britain's limited resources are deployed to the best possible advantage. Apart, however, from the questions whether sufficient readjustments have been made elsewhere in our defence programme and whether all that is possible has been achieved in the way of co-operation within the North Atlantic Treaty Organization or with the United States, other doubts have arisen from the limitations of our knowledge of the biological effects of radiations generated in nuclear explosions. These misgivings may well be largely dispelled when the promised report from the Medical Research Council is published; but there will then still remain the moral question whether the use of nuclear, and especially thermonuclear, weapons is ultimately justifiable.

That this aspect is profoundly disturbing even to those who accept the Government's decision as right and as inescapable at present is to be seen, for example, in the leading article, "The Moral Crisis", which appeared in *The Times* of March 14, and which was quoted by the Archbishop of York in the most outstanding speech in the debate on defence in the House of Lords on March 16. Dr. Garbett said that the decision raises moral and ethical questions of the first importance. Lasting peace, he said, will be achieved only by facing the moral issue and accepting the moral responsibility, realistically and unflinchingly. It requires vision and imagination, clarity of thought, and strength.

Dr. Garbett made no secret of his dislike of nuclear weapons. "I would to God they had never been invented", he said. But he recognized also that we cannot put back the clock, that we must face the possibilities of abuse, just as we accept the prospect of using these same scientific developments to provide new sources of industrial power, and that the decision whether or not thermonuclear bombs are used does not rest with Britain alone. It rests with those who would be quite uninfluenced by protests and decisions, and Dr. Garbett said he could not accept the argument that we could secure even our own safety by a unilateral renunciation of such weapons. He does not think that a democratic government can refuse to make such weapons unless it is certain that the great majority of those it represents are deliberately prepared to accept the consequences, with the destruction of our way of life and the obliteration of individual human values, quite apart from the sufferings which would be brought to millions. It cannot be claimed to-day that Britain is overwhelmingly pacifist, and he agreed rather with Lord Swinton that the mere fact that a peace-loving nation like our own possesses these bombs might prevent the bomb from ever being used for fear of the retaliation which would follow. The chief justification for making the bombs must be that they would provide a shield behind which the work of peace-making can be continued. Almost any road is worth exploring if it will lead to peace; almost any risk is worth taking if it will help to dispose of the suspicion and fear which lead to war.

As part of this desperate and continuous effort to create an atmosphere in which peace will be lasting, Dr. Garbett urged that Britain and others must be made fully aware of the destructiveness of this weapon. There was evidence enough in the defence debates to justify his doubts whether the people living behind the Iron Curtain are allowed to know about the results which would follow the use of the thermonuclear bomb. Nevertheless, he thought it would be possible and worth while for men of science of all nations to draw up a simple statement of the ruin which nuclear warfare would bring to the world. If the Communist powers refused to circulate it, the democracies should use every possible means to enlighten the people of the world as to the consequences of the use by their rulers of nuclear bombs.

What has been made clear above all by the Archbishop of York's speech is that the decision to make the bombs is not enough by itself, even as deterrent. The deterrence lies also in the steadiness and determination of men's minds, and the great merit of such papers as those of Edward Teller, "The Work of Many People" (*Science*, **121**, 267; 1955), J. R. Schenken, "The Scientist as a Citizen" (*ibid.*, **121**, 184), Gerard Piel's "Need for Public Understanding of Science" (*ibid.*, **121**, 317), or Prof. C. F. Powell's address at the "H-Bomb and Gun" Conference in London on February 26, is that they encourage the clear thinking and understanding of all that is involved, which are demanded no less of the scientist himself than of the ordinary citizen. They help to provide the perspective against which sound judgments and right decisions can be made.

It must be remembered, for example, that the great advances in nuclear physics which have placed these vast powers for good or evil in our hands are not accidental. They are the outcome of an approach, relatively new in human history, to the problem of winning knowledge and control from Nature; and while their implications for human life, as Prof. Powell observes, far surpass anything which has gone before, the discoveries themselves follow from the discoveries of the past. We have entered an epoch marked by ceaseless technical innovation, with all the perplexities and opportunities which are thus created, and any attempt to anticipate the course of events, in very general terms, must allow for the possibility of new discoveries and innovations.

Prof. Powell's main emphasis is on the instability of the present position and the heavy responsibility resting on those who have some small understanding of the great issues that are in suspense. In a position so precarious, small forces can turn the balance, and our prospects will be brighter the more people are

convinced, and the more firmly and untiringly they insist, that international agreement on nuclear energy can be achieved, that it is essential for our survival, and that it must be achieved in a form which respects the freedom of all peoples to determine their own destinies. That position is essentially the one adopted by Dr. Garbett. Prof. Powell's address is of even greater interest as a complement to the picture which Edward Teller gives of the development of the thermonuclear bomb and the way it involved the contributions of a considerable number of people, ranging from political decisions, to organization and to scientific work.

Teller believes that everyone who has worked on the thermonuclear bomb was appalled by the success and by its possible consequences, but that all connected in any way with the effort were convinced that the work was necessary. He believes that it was necessary to develop the thermonuclear bomb; and that in spite of the danger inherent in its destructive power we should be unfaithful to the tradition of Western civilization if we refused to explore the limits of human achievement. That is the specific duty of the scientist: beyond exploring and explaining, his responsibilities are no greater than those of any other citizen of a democratic society, many of whom have been associated with the scientist in this greater technical achievement.

To be in possession of the thermonuclear weapon is a greater challenge to the free community than its construction was to the technical people. Teller is confident that whatever the scientists are able to discover or invent, the people will be good enough and wise enough to control it for the ultimate benefit of everyone; though he gives no clue as to how and where we are to find and develop the habits of mind, in particular the power to transcend emotional inheritances—which people do not find easy—the virtues of prudence, justice and fortitude, as well as of faith, hope and charity, that will be needed more than ever in national and international policy in the more mobilized life which for the next generation at least we must be prepared to live.

In commenting on the Oppenheimer judgment last autumn, Teller says: "scientists as a group should stay out of politics except in areas touching on science". J. R. Schenken, in his article "The Scientist as a Citizen", shows that failure of the scientist to speak out clearly on the basic concepts of freedom endangers all the virtues which Teller now postulates as essential to enable the free world to meet the challenge of thermonuclear weapons. It is the minority, and not the majority, who challenge truth and create new concepts; and freedom exists only as long as the majority recognizes that the minority must be free to pursue thought wherever it may lead.

Schenken is concerned particularly with the position of medicine, and the prospect that it would remain outside the domain of security regulations, political restraints and the like. He rightly insists on the necessity of broadening the educational basis of medicine, so as to prevent the physician from becoming so engrossed in his own special field that, forgetting to look after the common good, he loses his right to continue unhampered even his scientific activities; but he overlooks the point made by Dr. Garbett, that those activities are already conditioned by the social milieu in which he works. We cannot disregard the fact that the utterances and activities of scientists behind the Iron Curtain are conditioned rather by the decrees of the State than by their professional discipline.

That fact cannot be ignored in considering the moral responsibility of the scientist as a citizen, and in weighing proposals for broadening professional education and bringing the scientist into closer touch with his fellow citizens. It must be remembered, too, in considering means of furthering public understanding of science. Unless the limitations of science and the scientist are clearly understood, there is danger that the scientist may be expected to exercise powers which he does not possess and which inhere in the community as a whole; or that, blaming the scientist for consequences for which he has no responsibility as a scientist, the community may refuse to support work which is essential for its own safety and welfare. The major movements in arts and letters to-day, remarks Gerard Piel, are anti-scientific in spirit.

National security and the relation between science and government have not been damaged in Britain to the extent which they have in the United States by the obsession with secrecy and the ignorance of science from which it springs, to which Piel refers. He quotes a recent statement of Dr. Vannevar Bush that the mutual respect between the scientific community and the military services achieved during the Second World War has been "almost destroyed and one of the principal reasons is the security system". We are concerned here, however, with the relations between the scientific community and the nation as a whole. Unless those relations are based on a clear conception of the nature of the scientific enterprise and the way the scientist works, the leaders of the community are unlikely to take the right decisions regarding the development and use of thermonuclear weapons, or indeed of nuclear energy in general, or the community to understand and support the essential decisions.

This is not to be interpreted as disregarding the moral qualities emphasized by Teller; on the contrary, it means dispelling the false, purely materialistic view of science. The taxpayer must be shown that science is not solely or simply a branch of technology, and that mere utility does not provide sufficient motive to inspire the curiosity, the initiative, the imagination, and the persistence that are embodied in all great work. As Warren Weaver expressed it in a passage quoted by Piel: "The most imaginative and powerful movements in the history of science have arisen not from plan, not from compulsion, but from the spontaneous enthusiasm and curiosity of competent individuals who had the freedom to think about the things they considered interesting".

There can, indeed, be no retreat from reason without disaster. The human mind cannot deny for long the inescapable conclusions of its capacity to know

and think; and science does broaden and secure the ground upon which men can choose their way of life. If it were clearly understood by the peoples on both sides of the Iron Curtain that the use of thermonuclear weapons in war might put an end to the human race, there might well be no risk of war; but as Lord Russell has said emphatically, it is not enough for one side only to understand the peril of war to-day.

Whatever practical measures can be found to ensure that that peril is clearly understood by both sides, it is important that the limited responsibilities of the scientists as such should be clearly understood. A declaration by eminent scientists that they may no longer be able to help any State to realize its policies seems rather to impute political knowledge and responsibilities which scientists do not possess. Accordingly, it may well be less calculated to serve the establishment of peaceful existence than the report suggested by Dr. Garbett, or Lord Russell's second proposal that a neutral power should draw up a report by experts on the probable consequences of war, designed to elicit the simultaneous admission by both sides to the neutral power that war could not serve their purposes.

These are issues about which the scientist, as such, and as a citizen, should be thinking intensively and constructively. On him rests a large measure of responsibility for creating a clear public understanding, for removing misapprehensions and for making sure that public policy is effectively criticized if at any point it falls short of technical or scientific requirements in respect of safety or welfare. If that responsibility is not accepted by him, it can be undertaken by no one. While the scientist has neither competence nor responsibility as such for the framing of policy, it is his peculiar responsibility as a citizen, both individually and collectively through his professional associations, to see that the technical and scientific issues involved are clearly understood by those concerned, and that both government and governed are in no doubt as to the implications of particular decisions, such as that to undertake the manufacture of thermonuclear weapons.

ANIMAL POPULATION PROBLEMS

The Natural Regulation of Animal Numbers

By Dr. David Lack. Pp. viii+343. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 35*s*. net.

THE fluctuation of the sizes of natural populations is extremely restricted compared with what is theoretically possible. In this book, Dr. David Lack sets out to formulate and clarify the problems presented by this fact. About three-quarters of the book is concerned with birds, since the factors regulating natural populations of birds have been particularly studied. In addition, he discusses the problem as it is found in the mammals, fish and insects.

Birds and other animals can increase in numbers with great rapidity, but are usually held drastically in check. The comparative stability of animal populations, nearly all of which fluctuate between restricted limits, is due to density-dependent controlling factors. Natural selection has moulded the evolution of the reproduction-rate of each species so that the greatest number of young survives to independence. Among mammals and birds, at least, the larger the family above a certain size the fewer the young that survive, for the death-rate is higher when there are more young to share a limited food supply. In birds the number of eggs laid is not the maximum that the adult is physiologically capable of producing; it is limited to the normal clutch-size, which has been determined by the evolutionary processes of each species as the most advantageous. But a rise in population-density has little if any effect on the clutch-size of each breeding pair, although in some mammals starvation does reduce fecundity; in most animals density-dependent variations affect the death-rate much more than the reproduction-rate.

In passerine birds 45 to nearly 70 per cent of the eggs laid produce flying young; in nidifugous species only about 25 per cent. But yearlings have a higher death-rate than adults, and consequently only some 8–18 per cent of the eggs laid produce breeding adults—a much higher proportion than in fish and invertebrates. The annual death-rate ranges from 30 to 60 per cent in most birds, but is as low as 10 per cent in one species of penguin, and these proportions are constant with respect to age. But wild birds—and almost all other wild animals—live only a fraction of their potential life-span, so that when the reproduction-rate is high so too is the adult death-rate, since in a stable population the death-rate balances the birth-rate; the suggestion that the reproduction rate of each species is adapted to its mortality is a fallacy.

Food shortage, predation and disease are the three factors most likely to cause a high mortality when the population density is high, because they can act more severely when numbers are large. The most important of these appears to be food shortage for the majority of species, though the others may have a larger effect in a minority; but it is seldom that either acts alone, and they commonly interact in a complex way. "Probably they interact in every species, though in some species one of them outweighs the others in importance. Their influence may also be modified by factors which, in themselves, act independently of density, and by irregular variations in climate. Finally, the numbers present or breeding in a particular area may be much modified by movements, which are usually adapted to the food supply." The author concludes that reproduction rates are a product of natural selection and are as efficient as possible. "They may vary somewhat with population-density, but the main density-dependent control of numbers probably comes through variations in the death rate. The critical mortality factors are food shortage, predation and disease, one of which may be paramount, though they often act together."

It is interesting that this synthesis of the results of the latest researches on the populations of animals takes us right back to Malthus, who concluded that "the ultimate check to population appears to be want of food . . . but the immediate checks . . . are all resolvable into moral restraint, vice and misery".

The populations of some species of animal undergo regular cycles of increase and decrease in numbers;

there is a four-year cycle, centred on the lemming, in the numbers of mammals and birds on the arctic tundra; a four-year cycle, centred on the vole, in the adjacent open forest; and a ten-year cycle, centred on the Varying hare, in the forests of North America. The graphs representing the size of the population of these species regularly rise to a peak followed by a deep trough. There seems to be no reason for believing that man is subject to biological laws different from those affecting the other animals; the human population of the world has been rising for many years—it has not yet reached its peak, but inevitably it will. The slope of the curve becomes ever steeper, not owing to man's fecundity, which has always been great, but owing to his control of the environment by his great engineering works to improve agriculture, and by his deliberate activities to improve production and reduce mortality through such organizations as the Food and Agriculture Organization and the World Health Organization. The crash is bound to come, and the human population, just like animal populations, is rapidly producing the means of its own destruction—it is possible and, according to some opinion, even probable that he has already contaminated his environment with artificial radioactive substances sufficiently to endanger his survival. There is only one means of escape, if indeed it is not already too late, and that is by devising ways of preventing the birth of unwanted numbers, rather than slaughtering them by mass destruction after they have been brought into the world. The surface of the earth is finite, and the amount of food that it can produce is limited; but long before the limit is reached the human population problem will have been solved—one way or the other.

Dr. Lack's interesting and stimulating book gives these matters only a brief mention in his last paragraph, but the whole of the preceding pages leading up to it makes it quite plain that in spite of religious, political and other prejudices and inhibitions, man is going the same way that all animal populations go when the birth- and death-rates do not balance: if he does not wish to increase the latter, he must control and decrease the former.

L. Harrison Matthews

ADMINISTRATIVE MEDICINE

Administrative Medicine

Transactions of the Second Conference, December 8, 9 and 10, 1953. Edited by George S. Stevenson. Pp. 164. (New York: Josiah Macy, Jr., Foundation, 1954.) 3 dollars.

BELIEVING that there is "a considerable obstruction to communication and mutual understanding across the disciplines and specialties" and that this is one of the major factors delaying scientific advancement, the Josiah Macy, Jr., Foundation arranges a series of annual conferences in which participates a small group of investigators representing, so far as possible, all the branches of science related to a chosen programme. The aim is to keep the meetings as informal as possible and to encourage the exchange of methods, research plans, concepts and difficulties; the informal nature and tempo of the discussion are preserved in the published transactions. The second programme on administrative medicine included a study of major components of administrative medicine, home-care programmes and the health services of the Department of Health for Scotland. This conference was attended by twenty-four persons, authorities on differing aspects of administrative medicine—university professors, public health service chiefs, hospital directors, directors of nursing services, directors of health insurance plans, directors of security departments of industrial firms, directors of research programmes, etc. Sir Andrew Davidson, then chief medical officer of the Department of Health for Scotland, was one of the guests.

Summarizing the proceedings of the conference, the chairman, Prof. H. R. Leavell, professor of public health practice at Harvard University, said it had emerged that administrative process has several phases: the recognition that a problem exists; definition of the problem and planning to meet it; development of a strategy of control; performance; and analysis or evaluation. Different types of administrators may be required to deal with each of these phases, though occasionally the necessary qualities may be found in a single (exceptional) individual. Team-work is important.

The personal qualifications of the administrator were discussed, and it was decided that he should be a good mixer, have a sense of humour and a sense of proportion, enthusiasm for his job, a special kind of motivation, and the kind of vision which enables him to visualize and project (perhaps less for certain phases of the administrative process than for others). In addition, he must have training to help him to do his job more effectively, a knowledge of the problem with which he is dealing, a capacity for realizing when he should seek advice, the ability to organize technical personnel and equipment and to relate them to the people to be served; and enough judgment to gauge the probability of success.

T. Ferguson

FREEDOM AND AUTHORITY

Freedom and Control in Modern Society

Edited by Prof. Morroe Berger, Prof. Theodore Abel and Prof. Charles H. Page. (The Van Nostrand Series in Sociology.) Pp. xii+326. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1954.) 45*s*. net.

THE fourteen essays comprising this book discuss those problems of individual freedom in an age of large-scale organization, of group relations and the relation of the individual to his government, which have engaged the interest and work of Robert M. MacIver. Further, the essays are written by scholars who admired MacIver, or who have been his students or colleagues; two of them, those by David Spitz and by Harry Alpert, respectively, attempt to evaluate Prof. MacIver's contribution to political and to sociological theory, the former including an appreciation of his theory of political obligation and the way in which MacIver's elaboration of this theory suggests that, within a democracy, means can be found of respecting the ultimate value of personality consistent with the maintenance of the social order.

The remaining essays range over such topics as friendship as a social process, the problem of authority, the political process in trade unions, social groups in the modern world, social structure and goals in group

relations, ethnic groups in America, the interplay of politics and economics in America's changing capitalism, and social change in Soviet Russia. In length and quality the contributions are uneven; but some are much below the standard of the rest. What will most impress any reader familiar with Prof. MacIver's own pellucid style, to which Alpert pays a well-deserved tribute, is the extent to which a volume written in MacIver's honour falls short of the high standard of exposition which he set. This is not true of all the essays: that of Prof. George Catlin on the utility of political science, like those by Spitz and Alpert, is happily free from jargon; but there is sufficient evidence in this book to support the charge of atrocious writing that Alpert brings against much American sociology in his own essay.

For that reason, it is difficult to assess the value of the book as a whole. It is not to be expected that the specialist will gather much that is new from such a volume, and the pleasure he finds in a tribute to an esteemed colleague cannot but be marred when the expression of that tribute falls so far short of the standard associated with MacIver. More serious is that, in a book addressed at least to a considerable extent to the general reader, a lapse from high standards of exposition into jargon which is largely unintelligible except to the specialist is unfortunate if not reprehensible. The sociologist is entitled to have his own special terms: indeed, it is essential that he should take particular care to define his terms, in view of the varying and loose meanings which are given to such words as 'freedom' and 'authority' in common parlance, let alone in political debate. If, however, he is to make a real contribution in clarifying the ideas of men and women, he must be particularly careful to present the results of his thinking in language which ordinary men and women can understand, and which will neither confuse nor repel them. That this is possible several of these essays demonstrate, notably those of Thomas Cook on individual liberty and Kingsley Davis on the demographic foundations of national power, in addition to those authors already mentioned; it is also demonstrated by a British writer, Sir Ernest Barker, with whose thought MacIver's has something in common. But there is much in this book that, for the reason just given, will do little to advance public understanding of the vital problem of freedom and control in modern society or, as is perhaps more familiar to us, of the responsible exercise of power.

R. BRIGHTMAN

DISEASES OF FARM ANIMALS IN BRITAIN

Farm Animals in Health and Disease

By Dr. W. R. Wooldridge. Pp. xvi+463+56 plates. (London: Crosby Lockwood and Son, Ltd., 1954.) 30*s*. net.

THIS book is not a scientific text-book but a serious attempt to produce a book for farmers which gives a sensible and reasoned approach to the diseases of animals. It is not another book which gives a number of disjointed and confusing technical facts along with a larger number of 'home' remedies; but it tries successfully to put the question of animal disease into a proper perspective. In consequence, it could be read usefully by everyone interested in livestock production.

The book is divided into two parts: the first covers general aspects of animal disease and the second deals with specific troubles. The first part is subdivided into four main chapters: (1) Good health, in which the normal functioning of the body is simply but well described. (2) Ill-health, in which the general signs of ill-health are given and the causes of disease sensibly set out with proper emphasis on factors other than the microbe. (3) The cost of ill-health, which perhaps cannot be estimated as accurately as one could wish or as the chapter might suggest. (4) The control of disease, which is quite rightly the longest chapter in the section. In this chapter various means of control are well described. The success of legislative and police methods is shown by the complete eradication from Great Britain of cattle plague, bovine pleuropneumonia, sheep pox and scab, rabies and glanders, while foot-and-mouth disease and anthrax are adequately controlled. The control of tuberculosis, swine fever and contagious abortion is also discussed. This chapter also clearly sets out the various aspects of preventive medicine and shows how prevention of disease depends upon early and proper diagnosis, specific vaccines and drugs, good nutrition and management, proper breeding and good pasture management.

The second part deals with the specific diseases of cattle, sheep, goats, pigs, horses, poultry and the rabbit. The chapter on cattle begins with a number of statements of fact regarding numbers of bulls licensed, the amount of food consumed and the economics of the milk and meat trades, and this is followed by a short summary of hygiene on the cattle farm. The third part of the chapter deals with the notifiable diseases, and the information given regarding foot-and-mouth disease and tuberculosis, although brief, is adequate for the purpose. In other sections the calfhood diseases are also adequately described and the attempt to present the predisposing factors is as good as present scientific knowledge permits. The information regarding Johne's disease in cattle could possibly have been more definite regarding the difficulty of control and the inadequacy of the johnin test for this purpose. The metabolic diseases of cattle such as milk fever, hypomagnesæmia, acetonæmia and bloat are described briefly, perhaps too briefly, as, for example, in the case of hypomagnesæmia, where greater detail regarding the prevention of the disease by giving additional magnesium either as a mineral supplement or as a pasture fertilizer would have been of practical help to the stockman. Mastitis, contagious abortion and infertility are sufficiently described, although certain features could usefully have been emphasized.

The chapter on sheep diseases quite rightly relates husbandry and disease, and many excellent examples of this relationship are given (although several of the statements could be debated). It is considered that, taking into account the briefness of the chapter, the description of the diseases of the sheep is adequate, but is not sufficient for those really interested and practised in sheep husbandry.

Despite these criticisms, the book is well written and will be useful as a guide to the stockowner and agriculturist, especially those chapters in part one. The second half of the book could also be useful provided it is not mistakenly used as a reference book to give the answer to all the questions of animal disease.

The book is well produced and has many good photographs.

J. T. STAMP

Rendiconti Istituto Superiore di Sanità

Vol. 17. English edition. Pp. x+243+46 plates. (Roma: Fondazione Emanuele Paterno; Oxford: Blackwell Scientific Publications, Ltd., 1954.) 5,000 lire; 57*s*. 6*d*.

THIS volume consists of twelve individual and largely unrelated contributions from different authors, each with a summary in English, French, German and Italian. Of these contributions, the majority comprise detailed descriptions of the construction and installation of fermentation vessels ranging in size from 10 to 300 litres capacity and adapted for fermentation research either in aerated or submerged culture. The remaining contributions include chapters on the interrelation of protein and polynucleotide synthesis in *Escherichia coli*, *Romanoa* —a new genus of antibacterial soil fungus—and two particularly interesting and topical papers by G. Sermonti on heterokaryosis in *Penicillium chrysogenum*.

The technological character of many of these papers must obviously limit the appeal of the volume as a whole. On the other hand, the detailed descriptions, maintenance, specifications and scale drawings of the apparatus described must equally ensure that anyone concerned with experimental fermentation plant will find the experience embodied in these papers invaluable. Many commonly encountered difficulties, such as turbulence, aeration and foaming, have been taken into account, but it must still be a matter for some regret that this lavish publication is likely, in respect of its technical sections, to become outdated within a comparatively short time as the special needs of research lead inevitably to modifications of small-scale fermentation apparatus. The scientific chapters form a group of original contributions in orthodox form, and these must secure a permanent place in scientific literature for the volume as a whole. A. H. Cook

Stability Theory of Differential Equations

By Richard Bellman. (International Series in Pure and Applied Mathematics.) Pp. xiii+166. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 44*s*.

THIS volume is introductory and elementary and the account is self-contained. It is a good text for the student about to begin research into stability theory. The style is attractive and does not suffer from the over-concentration so common in contemporary mathematical writing. Each chapter carries a number of exercises and there is a good bibliography, although there are not many references to the work published during the past five or six years.

The first chapter is concerned with the properties of linear systems. The necessary results in matrix theory are stated clearly, and the student unacquainted with the matrix calculus can read the account with ease. The main topic is the study of the asymptotic behaviour of the solutions of the equation $y' = Ay$, where A is a constant matrix. In the second chapter the equation $z' = [A + B(t)]z$ is considered, where the matrix $B(t)$ is, in some sense, small as $t \to \infty$. Stability, boundedness and asymptotic behaviour are investigated. Chapters 3 and 4 are concerned with non-linear systems. Two powerful methods are presented: (1) successive approximations, (2) approximation of the differential equations by difference equations. The results of Poincaré and Liapounoff on stability are developed. Chapter 5 is a short one on the polynomial equation $P(t,u,u') = 0$, and in Chapter 6 the well-known equation $u'' + a(t)u = 0$ is studied. The results are "a combination of ingenuity and special techniques". The last chapter concerns the Emden–Fowler equation $u'' \pm t^m u^n = 0$. L. S. Goddard

Mémoires sur la Théorie des Systèmes des Équations Différentielles Linéaires

Par J. A. Lappo-Danilevsky. Vols. 1, 2, 3 bound as one Volume. Pp. xiv+253+208+204. (New York: Chelsea Publishing Company, 1953.) 10 dollars.

IN 1931, J. A. Lappo-Danilevsky, a gifted young Russian mathematician, died suddenly, leaving a great quantity of unpublished work. The Academy of Sciences of the U.S.S.R. made a careful study of this, and in 1933 began the publication in French of these three volumes, which incorporate both the published and unpublished work of Lappo-Danilevsky, with corrections and supplements where necessary. Apparently Western mathematicians took little notice of it until about twenty years later.

The subject of the work is the use of matrices for the discussion of a set of linear differential equations. It is true that this method had been previously used by others, including G. Peano, G. D. Birkhoff and H. F. Baker; but none of these seems to have treated the subject so fully and successfully as Lappo-Danilevsky. As a preliminary, he discusses functions of a matrix variable. His first application to differential equations is to a problem of Poincaré, obtaining results fuller than those of Poincaré himself. Other applications to differential and integral equations follow. There is a unity and naturalness about the work which is very attractive, though the extent of the preliminary theorems required makes the book by no means easy reading. H. T. H. Piaggio

Metallurgy of Welding

By Prof. Walter H. Bruckner. (Pitman Metallurgy Series.) Pp. xii+290. (London: Sir Isaac Pitman and Sons, Ltd., 1954.) 30*s*. net.

THIS book gives a useful and clearly illustrated account, although in rather a dull style, of the principles and practice of the various methods of welding, their metallurgical aspects, and details of the structure and properties of the metal in the weld region. The treatment includes discussion of heat-flow in metals, considerations of residual stress, weldability, specifications and economic factors. In addition, the author deals with brazing, hard-facing, flame-hardening and metal-spraying.

A specific criticism, especially with respect to the chapter on metallic-arc welding, is that the reader cannot always be sure whether the discussion applies generally, or particularly, to steel. Further, there does not seem to be sufficient detailed and critical comparison of the merits of the various welding processes for specific metals, or of problems associated with particular metals. Another chapter, at least, is needed to discuss the welding of the major metals, separately.

It is generally assumed that the reader has a good background of metallurgical knowledge. Thus, engineers without such knowledge would need to consult first a text-book of engineering metallurgy. It must also be realized that this is an American book and refers predominantly to practice, specifications and literature in the United States.

A. R. Bailey

FIFTY YEARS OF THE THEORY OF RELATIVITY

By Prof. ANDRÉ MERCIER
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EINSTEIN'S first paper on relativity dates from 1905 ("Zur Elektrodynamik bewegter Körper", *Ann. der Phys.*, **17**, 891; 1905). Its immense importance invites us to renewed reflexion at the time of the jubilee of its publication. Prof. Einstein's death has thrown a shadow over the Jubilee Conference to be held in Berne in July, but will only deepen the earnestness of its work.

The influence and the consequences of Einsteinian relativity can be considered from three of four main aspects: special relativity, cosmology, the theory of knowledge, and the claim for unitary field theories. We shall not follow exactly this classification, nor shall we take up the historical view, which is well known; we shall look for the achievements in the light of contemporary thoughts.

First, we can develop neither experimental nor theoretical modern micro-physics without taking scrupulous account of the requirements of special relativity. This implies in particular reference to Lorentz covariance in every consideration of relative movements, and integration of mass (mc^2) in all energetic processes. Now quantum theory—though already built up on relativistic considerations by Einstein's initial idea of the photon as well as by de Broglie's concept of material waves—has developed for many years in a non-relativistic form which, of course, one hoped might be a mere Newtonian approximation of a correct relativistic quantum theory. On one hand, there is Dirac's theory of spin-particles, with all the extraordinary consequences of antiparticles as holes in the negative energy-states, of polarizability of vacuum, divergent self-energies and so on; and, on the other hand, the formulation by Heisenberg and Pauli of a theory of quantum fields which from the beginning was given a relativistic background. Despite the difficulties mentioned, both have had an illustrious career, and we can say *grosso modo* that the elaboration of a relativistic micro-physics has been a success.

But there are two important aspects where we must recognize the limits of that great attempt. One is, that the quantum theory, even in its most modern form of relativistic quantum fields, is almost certainly not capable of tackling the real problems of nuclear physics and the behaviour of so-called fundamental (elementary) particles. The other is that, though many theoreticians have developed formalisms to get over the difficulties concerning infinite self-energies and the like, these formalisms are artifices; the difficulties remain and are inherent in the theory as a whole. Furthermore, the relativistic treatment of systems of material bodies or particles is more or less Utopian. So one gets the impression that there is some incongruity and some insufficiency in relativistic quantum theory. Maybe this is not independent of the fact that special relativity symmetrizes time and space co-ordinates, whereas the statistical conception which runs through the whole of the quantum theory makes time a typically singular variable. Now this statistical conception is a corollary of complementarity; therefore, we should not be too surprised if at some time it should be discovered that a quantum conception and a relativistic conception require a framework of a higher learning if they are to co-exist without any inconsistency whatever.

In some ways, the substitution of Einsteinian relativity for Galilean relativity is a simplification, because it leads towards a more unified model of Nature than did the preceding one. At the same time, categories such as time and space, in the Kantian sense of the *a priori*'s, have lost their independence and so we have come, in a sense, nearer to a thorough understanding of Nature. But at the same time, too, one gets the feeling that intuition has lost its connexion with space and time; they are no longer the same "Formen der Anschauung". So we come automatically to a discussion of the epistemological, and consequently the philosophical, aspects of the theory of relativity, or at least a part of it, as we have so far considered only special, and not general, relativity.

The idea seems to have spread among a number of modern scientists that science, as it grows, will more and more reduce the field of, and absorb, philosophy, or at least metaphysics, until eventually it may disappear as a necessary activity of the human mind. I have actually heard that opinion expressed more than once. But the opinion is due to a misunderstanding consisting in the belief that science grasps the 'problems' of metaphysics one after the other and solves them, so that there remains no philosophical basis at all. But that is not what really happens: the process goes the other way. Philosophy does not 'solve problems', whereas science does. Philosophy, in its relation to science, gathers up the problems of science, which are no longer problems since they have found solutions, and seeks to order them in such a way that a structure of knowledge does, in fact, appear. When we speak of problems in philosophy, they have little in common with problems as they are put and solved in physics, for example. In this sense, special relativity has helped philosophy to take a considerable step forward in the 'problem' of time, that is, in the understanding of the genesis, of the independence, of the priority of the concept, in the distinction between several meanings of the concept of time, etc., and particularly in its correct classification among the categories. This last point has opened the first attack against Comte's positivistic classification of the sciences, and thus one must see in special relativity the beginning of a new era in epistemology and the methodology of science (though it is often seen first in the rise and influence of general relativity doing away with Euclidean space as the 'only' possible one).

There is no doubt that Einsteinian space–time relativity gives rise to serious difficulties to the understanding. Everybody *sees* the bodies of the world *change* their situation, not only spatially, but also in every aspect of their (macroscopic) physical state; and all these changes *take place in the course of time*. Therefore, it appears most natural that physics should have developed in the form of the study of temporal changes, of 'evolution'—evolution referring merely to lifeless matter, as contrasted with biology. In this representation is to be found the core of the mechanistical conception of the world; and so it is not only a question of Newtonian

mechanics based on Galilean relativity having been taught at school, for about three centuries, that has made it so difficult for us in the twentieth century to appreciate the meaning of relativity: a natural relation of our intelligence to the things of the external world drives us towards a Galilean conception instead of the better, newer one. (The fact that Galilean relativity was not expressly recognized in times prior to Newtonian mechanics is connected with the lack of the mathematical means to formulate it.) Nevertheless, the force of habit is far from negligible, and there is no doubt that teaching the same theories in the schools for many generations makes us believe them to be the expression of a matter of evidence.

Neither an experiment nor a contradiction had for years invalidated that semblance of evidence—until Michelson's experiment and the discovery of the lack of Galilean covariance in Maxwell's electrodynamics.

The necessity of acknowledging the new evidence after having believed in the evidence of a state of mind always comes as a great shock. But it is wholesome for the spread of knowledge that we should learn about the frailty of formulæ which one might imprudently confuse with absolute truths. Two reasons, therefore, make it psychologically understandable that from the very beginning Einsteinian relativity met with great opposition from many quarters: namely, the force of habit in connexion with that fallacious evidence, and the natural feeling for temporal evolution.

Indeed, the latter point—temporal change of state—is not fallacious. Einsteinian relativity is not anti-mechanistical, but it takes away from time the character of being a (mathematically) independent variable and assigns it to another parameter which is no longer intuitive.

The acceptance of Einsteinian space–time relativity was due to the condition imposed on light propagation, and consequently for Maxwell's electromagnetic equation to remain unchanged in form in the course of co-ordinate substitutions. But the co-ordinates included time, and so the frame of Newtonian mechanics had become untenable; bearing in mind that Newtonian mechanics had been elaborated for the description of gravitation, it is understandable that the acceptance of (special) relativity should be bound up with a renunciation of the ability to describe gravitation. That left a considerable gap in physical theory. Einstein realized this, of course, and as soon as the main problems of special relativity were solved, he set about generalizing it in a way which would render possible the description of gravitation.

Now all known interactions of matter can be reduced to a few elementary interactions, each having its intensity characterized by a universal interaction constant. The two most important are gravitation (with the constant of gravitation) and the electromagnetic interaction (with the so-called dielectric constant of vacuum as the universal constant). All elastic, crystalline, molecular and atomic properties, for example, can be reduced to the latter. It is known to-day that the cohesion and radioactivity of nuclei go back to a third sort of elementary interaction for which a good theory is still lacking, but for which a universal constant, such as that which Fermi once introduced in his theory of β-radioactivity, will take over the role of settling its intrinsic intensity.

It is very curious that the first step made by Einstein pushed aside, so to speak, every reference to one of these fundamental interactions, namely, to gravitation, and was only suited to the electromagnetic one. He recognized that this was due to the restricted use of the so-called Galilean reference frames and the definition of (pseudo-) Euclidean geometry, and the old idea, already suggested by Riemann and by Clifford, of description in non-Euclidean spaces occurred to him. It is difficult not to be convinced by the idea, because (1) the passage from Euclidean to Riemannian geometry allows us to take over the fundamental postulate of covariance of laws; (2) the Euclidean case of special relativity appears in relation to the more general Riemannian one like the tangent to a curve and therefore as the approximation where curvature vanishes; and (3) the appearance of curvature of Riemannian space offers exactly the field where gravitation can once again be described. But—and it is as if it were a trick played at our expense by our own theoretical pursuit—the electromagnetic case does not find a natural place in the theory of relativity thus generalized.

So, on one hand, the theory of general relativity (in its original form at least) lost more or less the advantage that special relativity had gained. Its aim was to reassemble, to unify in a completely coherent manner, the descriptions of two different interactions. The first attempt led to a failure, and electromagnetism had to be reintegrated artificially—an unsatisfactory process in a theory which was defined as unified. So began the search for unitary field theories which is not yet ended, as no unitary theory yet proposed has been definitely recognized as the right one. On the other hand, the elaboration of general relativity revealed the theoretical possibility of world expansion, and the very fact that world expansion was suspected experimentally suggested the adoption of a fourth interaction with the cosmic constant as the measure of its intensity.

In that way, we are led to the two remaining principal aspects of relativity theory: to cosmology in the study of gravitation and world expansion, and to the search for unified field theories.

The general theory has been experimentally sustained in its cosmological consequences by some measurements; but we are very far from an experimental verification comparable with that of Newton's mechanics, with its precise account of Kepler's laws which were based on innumerable measurements collected by Tycho Brahe, or with Bohr's atomic theory, with its account of Balmer's formula and the like based again on countless experimental results. The movement of the perihelion of the planet Mercury could be explained by some queer law of force; the deflexion of light and the displacement of spectral lines are still feeble confirmations compared with what has been done in other fields of physics. Therefore, I should like to stress the importance which *reason* has had in the acceptance of the theory of relativity. Here again, excessive positivism has been destroyed. The dignity of pure theoretical speculation has been rehabilitated; not in the form of an arbitrary speculation, but based on a process of the mind with its own justification, which I should like to call the 'experience' of the theory.

Despite these remarks, it is not to be concluded that general relativity has no experimental background whatsoever. It is not merely an empirical science, though it is not pure mathematics; it is the

prototype of that theoretical endeavour which is one of the characteristic features of our scientific century. For this reason, Einstein is largely responsible for the moulding of contemporary thought.

General relativity has thus several bearings on philosophy. In the published literature, the substitution of non-Euclidean for Euclidean geometry has been insisted upon almost invariably. It lays considerable weight, of course, on the formation of the *Weltanschauung* and the like, and it requires (after space–time relativity had already done so) a renewed effort to overcome the old conception of naïve intuition. Moreover, general relativity (like, and still more than, special relativity) has reminded the philosopher of the Platonic adage of the ΕΙ Ο ΘΕΟΣ ΓΕΩΜΕΤΡΕΙ: it has saved science from narrow experimentalism, it has emphasized the part which beauty and simplicity must play in the formulation of theories of the nature of the physical world, and it has reinforced the conception of Heinrich Hertz that physics gives only models of that physical reality. But at the same time it has considerably modified this conception, because the models are no longer plainly mechanical: mathematics is the store where models are to be found, so mathematical abstraction is a necessary source even of positive knowledge.

In a sense, the theory of relativity is the fulfilment of classical physics so far as Newtonian determinism and Cartesian tradition are concerned. This alone would give it the right to praise; but in another sense, the theory of relativity is a liberation from classical physics on account of the completely unforeseen horizons it has opened up. It has afforded a liberation from crystallized criticism of science and towards unsuspected greatness, which amply justify us in commemorating the jubilee of its announcement.

RADIO RESEARCH STATION, DITTON PARK, BUCKS

By Dr. R. L. SMITH-ROSE, C.B.E.

ON May 16, representatives of technical staffs in the radio industry visited the Radio Research Station (Department of Scientific and Industrial Research) to meet the members of the Radio Research Board and its committees, and to inspect the work in progress at the Station. A wide range of exhibits and demonstrations was provided in the huts and temporary buildings of the Station at Ditton Park, near Datchet, Bucks.

It was following the Board's advice, given in 1946, that the Department of Scientific and Industrial Research accepted the recommendation of its Advisory Council that the programme of research previously conducted in the Radio Division of the National Physical Laboratory should be greatly expanded and administered independently under a new Radio Research Organization. Accordingly, in December 1947 the present writer was appointed director of the new organization, to which the radio staff of the National Physical Laboratory were later transferred. After reviewing the needs of the research programme and considering a number of alternative possibilities, the Radio Research Board endorsed a recommendation that the permanent site of the Radio Research Station should be at Ditton Park, in the grounds of the Admiralty Compass Observatory, where nearly 100 acres of the park have been used for field experimental work in radio over a number of years. In order to preserve the technical qualities of this park, another 100 acres of the neighbouring farm have been purchased by the Ministry of Works, mainly to ensure that the whole site is kept free from undesirable electrical interference with the radio research work. A small portion of it may be used for experimental work; but apart from this, the additional land will continue to be available to the farmer.

Research Programme

The programme of the Radio Research Organization is designed to assist in the solution of some of the problems which confront the various users of radio waves and radio-frequency techniques, whether for civil, military or industrial purposes. The major portion of the work for the past few years has been concerned with meeting the needs of the communication, broadcasting and radio navigation services, by studying the propagation of radio waves along the ground and through the lower and upper atmospheres, and taking account of the various types of disturbance caused by atmospherics of natural origin and by interference due to electrical equipment. Other portions of the programme include an investigation of the physical properties of certain materials, such as semiconductors and ferromagnetic compounds, which are of special interest in the radio field. The measurement of power and field-strength, particularly in the upper bands of radio-frequency, is also the subject of study and development.

Measurements are being made of the speed with which radio waves travel over land and sea, and the results correlated with geological structure and ground conductivity. The effects on wave transmission of irregularities in the ground and the presence of natural or man-made obstacles, such as hills, trees and buildings, are studied with the view of determining, for example, the probable service area of new television stations at increasingly higher frequencies.

The transmission of very short waves to distances beyond the horizon is largely determined by the vertical gradient and regularity of temperature, pressure and humidity in the lower atmosphere or troposphere. A long-term investigation is in progress on the relationship between radio and meteorological conditions in order to obtain the information required in assessing the performance of communication, broadcasting and television services; and especially for the future planning of such services, including radio links, at wave-lengths from a few metres down to a few centimetres.

The Radio Research Station is responsible for the maintenance of seven observatories, two in the United Kingdom and five on British territory overseas, which make a continuous study of the characteristics of the ionosphere by the vertical sounding technique. The results obtained at these observatories and at some seventy-five others maintained by other countries are used in the preparation of forecasts of radio transmission conditions all over the world, six

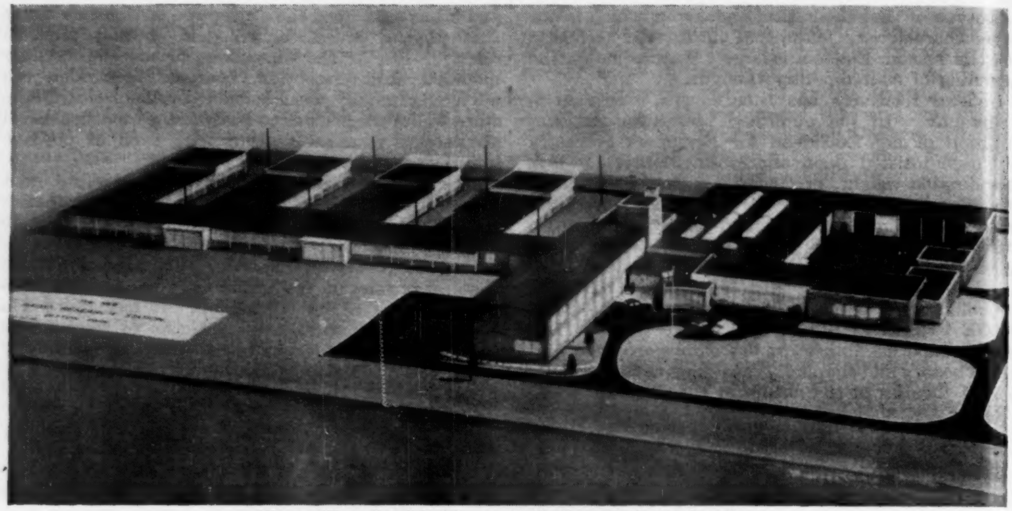

Fig. 1. View of model of the new Radio Research Station from front

months in advance. These forecasts are used on a wide scale by organizations operating broadcasting and communication services and by air and marine navigation services.

The technique of sounding the ionosphere has recently been extended to points remote from the observing station by measuring the characteristics of echoes received by a combination of ionospheric reflexion and scattering from the ground at distances up to 10,000 km. (6,000 miles) or more. The study of the nature, time and direction of arrival of such echoes is greatly increasing our knowledge of the manner in which radio waves are transmitted to great distances around the world.

The scope of the various radio services is frequently restricted by the background of noise against which the signals have to be observed. Much of this noise is due to atmospheric disturbances arising in thunderstorms and lightning flashes. Measurements of the intensity of this noise are made in various parts of the world with a uniform type of apparatus designed by the Radio Research Station. The characteristics of this disturbing noise are also under continuous investigation in order to develop means of mitigating its effects. Other apparatus for locating the sources of these atmospheric disturbances has been developed and is used by the Meteorological Office for supplying information on the position of storm centres for use in weather forecasting. An equipment for counting lightning flashes is under development in order to assist the meteorologist to supply information on the frequency and distribution of thunderstorms—information which is itself requested by the radio scientist.

Most of the apparatus required for these and similar investigations is of a highly specialized nature, and has been developed entirely at the Radio Research Station. In some cases, where the equipment is of interest to other users in Britain or abroad, a commercial firm has been assisted in reproducing it. Examples of such manufacture are the iono-

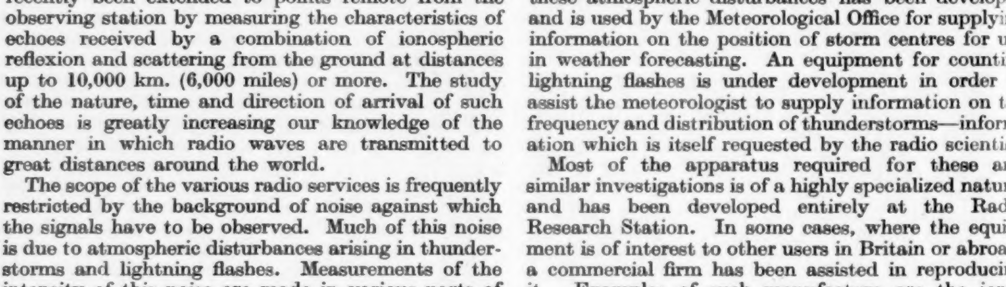

Fig. 2

spheric recording equipment, which is entirely automatic in operation, the cathode-ray direction finder for locating sources of atmospherics and the apparatus for measuring the strength of atmospheric noise on high and medium radio-frequencies.

New Buildings

The work of the Radio Research Station has hitherto been carried out in a number of temporary buildings which have been adapted with varying success to the needs of the research programme. With the expansion resulting from the Department's post-war programme, a permanent building has been designed by the architects of the Ministry of Works specifically to meet the research needs, and this building is now in course of erection. As will be seen from the accompanying photograph of a model (Fig. 1), the building will have at one end a two-story administrative block, together with all general services, workshops, stores, garages, dining room, etc., on the ground floor. The main portion of the building, containing the scientific laboratories, is of a single-story type with a backbone and four spurs, the ends of which open directly on to the field, which is regarded as a continuation of the laboratory space (Fig. 2). To make the best use of the field for experimental work, the building has been set to one side of the West Park, and every effort is being made to restrict the permanent metalwork in this and the other fields to the absolute minimum, so as to avoid any interference with the experimental work. A non-metallic pipe has been installed across the field to connect the waste outlet from the building with the main sewer, which itself is of non-metallic construction for the section across Ditton Park. The electric power supply for work in the field will be obtained by temporary connexion to one of a number of distribution outlets from a ring-main around the periphery. In order to reduce radio interference from the ignition systems of motor traffic to the minimum, the building is sited at a distance of more than 200 yards from the nearest public road; and most of the working parts of the fields in use are nearly half a mile from any major road carrying vehicular traffic.

Various huts of a temporary and transportable nature will also be used for field-work, the position of these over the land area available being determined by the nature of the experimental work, the size of the aerial systems required and the need to reduce mutual interference between investigations in the same vicinity. For special types of research, the use of isolated sites away from the Station will continue as in the past; and in some cases the work is conducted in various parts of the country in vehicles equipped as mobile laboratories. To facilitate the installation and calibration of apparatus in these, a covered space is provided at the end of each spur of the main building, so that the work can be conducted directly from the appropriate laboratory.

The present staff of the Radio Research Organization numbers just over a hundred. Most of these are now in temporary accommodation at Ditton Park; due to the insufficiency of this accommodation, however, a small number still work at the National Physical Laboratory, Teddington. When the new building is ready for occupation, all the staff will be brought together at the Radio Research Station, and a steady increase in their numbers may be expected to take place over the next few years to deal with the expanding research programme.

BRISTOL MEETING OF THE BRITISH ASSOCIATION

DURING the week August 31–September 7, the one hundred and seventeenth annual meeting of the British Association will be held in Bristol. This is the fifth occasion that the Association has met in Bristol, and all concerned with the arrangements are aiming at a meeting that will stand comparison with its predecessors.

Bristol was host to the British Association first in 1836, when Prof. Daubeny, of Oxford, addressed members on the progress of science during the previous year. In 1875 the presidential address by Sir John Hawkshaw, railway engineer and builder of the Severn Tunnel, was given in the Colston Hall, and considered whether nationalization of the railways might not be in the best interests of public safety and national economy. At one of the sectional transactions, Prof. Stanley Jevons read a paper "On the Progress of the Coal Question", concluding that "the coal famine of 1872–3 may be regarded as the first twinge of the scarcity which must come . . .".

The third Bristol meeting was held in 1898 with Sir William Crookes as president. His address dealt first with world food supply, but went on to discuss progress in pure science, particularly in his own chief interest molecular physics, saying "the store drawn upon naturally by uranium and other heavy atoms only awaits the touch of the magic wand of science to enable the Twentieth Century to cast into the shade the marvels of the Nineteenth".

The president for the fourth Bristol meeting, in 1930, was Prof. F. O. Bower, who, with Dr. R. E. Slade, showed how chemical science had helped to avert a world famine forecast by Sir William Crookes in 1898.

A brief glance at the preliminary programme will confirm that the high standard set by previous Bristol meetings has been maintained this year, and it will be interesting to see what new prophecies are forthcoming or what solutions have been found to age-old problems. This year's president, Sir Robert Robinson, is one of the world's greatest organic chemists, particularly noted for his research into the pigments of flowers and into the constitution of penicillin. At the inaugural general meeting he will speak on "Science and the Scientist", and as he is famed for being direct and candid, his audience at the Colston Hall can be assured of a lively and forthright address. During the week, as in past years, there will be television broadcasts of several items in addition to the usual sound broadcasts.

At the Colston Hall, the fourth to bear the name, and of them all the most perfect acoustically, there will be three evening discourses. The first of these will be given by Prof. C. F. Powell, of the University of Bristol, on "Experiments at Great Altitudes with Free Balloons", and will deal in part with nuclear physics in the very high-energy region. Prof. H. D. F. Kitto, professor of Greek in the University of Bristol, will give a discourse on "Scientific and Dramatic Modes of Thought", and Mr. B. J. C. Atkinson, of the Department of Prehistoric Archæology of the University of Edinburgh, will speak on "Stonehenge in the Light of Recent Research".

Among the addresses by presidents of Sections, mention may be made of Prof. N. F. Mott's to Section *A* on "The Physics of the Solid State", Sir Alexander Todd's to Section *B* on "Nucleic Acid Structure and Function", Dr. D. B. Harden's to Section *H* on "Anthropology: a Scientific Unity?" and Mr. J. F. Wolfenden's to Section *L* on "The Educated Man in 1955".

It is impossible to set out all the presidential addresses in this short article, or to mention in detail the many and varied subjects to be covered by the sixteen sections, but the programme contains something for everyone, scientist or layman—and possibly too much for the ardent enthusiast, who cannot hope to partake of all the fare provided. The sectional meeting rooms will be within short walking distances of the Reception Centre, and with one or two exceptions will be located in departments of the University. The reception room and administrative offices of the Reception Centre will be in the Victoria Rooms, which will also house an exhibition illustrating the work of the British North Greenland Expedition. Mr. R. A. Hamilton, chief scientist of the Expedition, will give a public afternoon lecture in the Colston Hall on "The Scientific Work of the British North Greenland Expedition", and other scientific members of the expedition will participate in the proceedings of certain sections. Another afternoon lecture to be given in the Colston Hall will be that by Mr. B. J. Mason, of the Department of Meteorology of the Imperial College of Science and Technology, London, on "Man's Influence on the Weather", dealing with progress and possibilities in weather modification.

In past years, scientific films have been shown at section meetings, and the last morning of the meeting has been devoted to the showing of films of scientific interest. This year, because of the interest shown at recent meetings and in view of the increasing importance of the film in scientific work—not least as a medium for the interpretation of science to the layman—it has been decided, with the aid of the Scientific Film Association, to have daily continuous screenings of outstanding scientific films in sessions of about three-hours duration in a film studio at the College of Technology in Unity Street. These sessions will be on a "News Theatre" basis, and visitors will be at liberty to wander in—and out—whenever they please.

On two evenings the City Museum will be open to members who might wish to consult the curators or examine the extensive collections. While the collections refer primarily to the West of England, it should also be noted that the archæological objects include Egyptian antiquities with the emphasis on the pre-dynastic and early dynastic periods, and some fine Greek vases. The ethnographical collections include Maori tattooed heads and a bronze head from Benin. The geological gallery was unfortunately destroyed in an air-raid in 1940; but the Chaning Pearce and Tutcher collections, both of which are rich in Mesozoic fossils from the West Country, are worth noting. The Lewis Collection of Somerset birds' eggs and nests is outstanding, and there are extensive collections of British shells. Among the insect collections there are several of British Lepidoptera which are specially interesting, as also is the Barton collection of Buprestidae. The Bristol Naturalists' Society is arranging a special exhibition on the two evenings on which the City Museum is open. While in Bristol many members will undoubtedly visit the Blaise Castle House Folk Museum and Folk Park, situated in a magnificently wooded estate of some 400 acres. The Folk Museum is a branch of the City Museum and contains collections ranging from the fifteenth to the nineteenth centuries illustrating English social and cultural history, with especial reference to the West of England.

This year's visit of the Association coincides with the eight-hundredth anniversary of the granting of Bristol's first charter by King Henry II, and a special exhibition to mark the occasion will be displayed in the City Museum. In addition, Prof. David Douglas, professor of history in the University of Bristol, will comment on the granting of the charter in his Saturday evening lecture at the Colston Hall on "The Living Past" and will discuss the contribution to be made by historical studies to the progress of the arts and sciences.

Scientists like other mortals must needs eat, and the local executive committee is doing its utmost to anticipate and meet the demands of even the most fastidious. Provisional block bookings of accommodation in hotels and boarding houses in the City have already been made, and the accommodation in Wills Hall (a university hall of residence), three theological colleges, and the Y.W.C.A. and Y.M.C.A. hostels in the City have been reserved. Owing to the demand for hotel accommodation in Bristol, however, the block reservations cannot be held after June 30 unless a definite booking has been received by the hotel from the individual member.

On the lighter side, Bristol has done its best to compile an attractive programme of excursions, both general and sectional, covering a fairly wide area of the south-west. In and around Bristol, visits will be made to many places of archæological, historical and industrial interest, and several firms and organizations have generously come forward with offers of hospitality in various forms which will undoubtedly add to the success of the meeting. The steamer excursions should provide a wonderful opportunity for relaxation.

One may perhaps add here that, in common with the Association's hosts in other cities in recent years, the Bristol Local Executive Committee is at present producing a scientific survey of the region, the whole cost of which will be borne by the local fund and which will surely prove an informative and invaluable souvenir of the meeting. While the venue of this year's meeting is Bristol, it should not be forgotten that neighbouring authorities are also contributing, though necessarily to a lesser degree, to the success of the local arrangements. For example, the Schools Science Exhibition which members will see in the College of Technology would not have been possible without the whole-hearted co-operation of the local education authorities, particularly as the exhibits will have been staged during the holiday period. This is the first occasion on which such an exhibition has been arranged in connexion with an annual meeting of the British Association, and is an indication of the increasing interest in scientific achievements.

Of recent years Bristol has earned the reputation of being a 'City of Flowers'. During the period of the meeting the beautiful floral displays will be at their best in the parks, at the City Centre, in patches of loveliness by footpaths and in the streets, and in hundreds of window-boxes and hanging baskets. For spectacle and perfection, however, members should visit the annual horticultural show in the lovely natural setting of Durdham Downs during the first three days of the meeting.

OBITUARY

Prof. Albert Einstein, For.Mem.R.S.

EINSTEIN was unquestionably the most famous scientist of modern times. There can be little doubt that he was also the greatest and that he was one of the very great thinkers of all time. He changed some of the most fundamental concepts in our thought about the physical world; to very few has it been given to do this. What was most significant in his work may appear simple and inevitable in retrospect; but it resulted from his having questioned some of the universally accepted physical assumptions that no one had ever challenged before.

Albert Einstein was born of German Jewish parents on March 14, 1879, at Ulm in Württemberg. He was educated at schools in Munich and at Aarau in Switzerland, and at the Federal Polytechnic School in Zurich. Having failed to obtain a teaching appointment, he found employment in the Swiss Patent Office in Berne. While holding a junior position there during 1902–8 he produced much of his most remarkable work, and an international gathering of scientists will meet at Berne this summer, at the invitation of their Swiss colleagues, to celebrate the jubilee of relativity theory. It is to the credit of the scientific world of the time that Einstein's early work was so readily published and given recognition. He was appointed successively *Privatdozent* in Berne (1908), extraordinary professor in Zurich (1909), professor of theoretical physics in Prague (1911), professor of theoretical physics in Zurich (1912) and director of the Kaiser Wilhelm Physical Institute and professor in the University of Berlin (1913). In 1933, when his position in Nazi Germany had become untenable, he accepted a professorship at the Institute for Advanced Studies in Princeton, which he held until his retirement in 1945, having meantime become an American citizen. He died at Princeton on April 18. In 1952 he had declined an invitation to become president of Israel. Einstein's first marriage, to Mileva Maritsch, by whom he had two sons, was dissolved, and in 1917 he married his cousin, Elsa Einstein, who died in 1936. He was awarded the Nobel Prize for Physics in 1921, the Copley Medal of the Royal Society in 1925, and very many other honours.

From an early age, Einstein had an unerring discernment of the fundamental problems in physics and a determination to devote himself to them. He was able to see ahead, even if only in broad outline, the main stages of what he set himself to achieve. In the tactics of research he was an opportunist, as in the help he got (and acknowledged) from Minkowski's geometrical ideas and from Ricci and Levi-Cività's tensor calculus, as well as in developments suggested by his own work. But he had a strategic plan that was all his own and to which he adhered. Although each of his major achievements was astonishingly complete in itself, in his view it was the gain of a limited objective that was to serve as a base for the next advance.

Einstein started his scientific work with a realization of the inadequacies of Newtonian mechanics both in its own fundamental formulation and also as a basis for physical theory in general. Many of the considerations were well known, but what impressed Einstein most was the fact that the rudimentary concepts of mechanics and of electrodynamics are so different. Moreover, about this time, Planck had given his theory of temperature-radiation and energy-quanta, and Einstein saw that it involved fundamental contradictions of both classical mechanics and electrodynamics.

The basic notion of electrodynamics is the 'field' and of mechanics it is the 'particle'. In the perplexing situation of those days and ever afterwards, Einstein expected progress to result from the further development of 'field-theory', or of the 'electromagnetic foundation of physics' as he called it, obviously using the expression in a very general sense. But he knew that he must always look for ways of accommodating the 'particle' aspects of physics.

Of all existing physical theory at that time, only classical thermodynamics seemed secure within its own domain and to offer a safe starting-point for fundamental investigations. So it was natural that Einstein's first papers (1901–5) should be on that subject and in particular on its statistical formulation. This led to his famous discovery (1905–6) of the true nature of Brownian movement as a manifestation of the heat-motion of 'molecules', a notion which it crucially vindicated, and his demonstration of the consequent possibility of determining molecular dimensions.

Einstein then observed that a mirror suitably suspended in an enclosure of temperature-radiation ought, in principle, to possess Brownian movement with mean energy appropriate to the temperature. This he showed to be incompatible with electromagnetic wave theory. On the other hand, he was able to show that it is consistent with the hypothesis that radiation of frequency ν interacts with matter, and is propagated, only in whole quanta of energy $h\nu$, where h is Planck's constant. He had already realized that this hypothesis would explain the observational properties of the photoelectric effect. These ideas he developed in his paper of 1905, which presented the concept of light-quanta in the form employed ever since. It freed Planck's ideas about energy-quanta from association with real or hypothetical oscillators and transformed the concept into one having universal physical significance. In this paper, Einstein also suggested that the wave-character of radiation could be treated as a statistical feature of its corpuscular character. Natural though this suggestion may have been, it was the first step towards reconciling the wave and particle aspects of physics, and so towards modern quantum mechanics. But Einstein called all this merely a "heuristic viewpoint".

He was convinced that true progress depended upon starting much further back. He set himself to find a new principle on the model of the thermodynamic principle requiring the laws of physics to be such that it is impossible to achieve perpetual motion of the 'first' or 'second' kinds. He recorded that it took him from the age of sixteen to twenty-six to find it in the form, coupled with the assumption of the constancy of the speed of light, requiring the laws of physics to be such that it is impossible to detect uniform motion relative to an inertial frame of reference (save, of course, by direct observation of the frame). The paper, also of 1905, in which Einstein developed the consequences of this principle could even to-day be given to a student as probably the best summary of the theory of (special) relativity. Remembering his preoccupation with the electromagnetic foundation of physics, it may be recalled that the title of the paper is "On the Electrodynamics of Moving Bodies".

Many features of the theory had been foreshadowed by other workers. In Einstein's intensely original presentation, these features fell into place in a system based upon a single principle. Moreover, Einstein saw a significance in the work that was beyond the range of vision of his predecessors. Their merit was in having so exposed the difficulties of the matters concerned that the magnitude of Einstein's achievement could the more readily be appreciated.

It was another ten years before Einstein attained what was almost certainly his greatest triumph, the theory of general relativity. The restrictions in the scope of the special theory are well known, as are also some of the considerations, particularly in regard to the equivalence of inertial and gravitational mass, that guided Einstein in removing the restrictions. He was guided also by Minkowski's geometrical formulation of special relativity. But in general relativity the geometry of space-time and what is happening in space-time are interdependent; hitherto it had been universally assumed that space-time had an independent existence. If ever any single advance may be called epoch-making, this is one that must earn the description. In whatever way physical theory may develop in the future, it cannot be believed that this step will ever be retraced. For it is easy to recognize that the behaviour of clocks, measuring-rods and light-signals must be related to the behaviour of the physical system of which they form part. It had previously been implicitly supposed that there nevertheless exists an underlying space-time that can somehow be 'explored' by the use of the measuring-rods, etc. In effect, Einstein showed the emptiness of this concept. When we consider what we call the spatial and temporal relationships of a physical system, we are concerned with aspects of its behaviour that cannot be conceived in separation from its other aspects.

It was one thing to appreciate the advance that was needed; it was another to give it mathematical expression. Einstein accomplished this in brilliant fashion in the limited domain of the 'general' theory. For he regarded this as being satisfactory only in its treatment of a pure gravitational field. He described as only 'makeshift' the way in which he introduced the matter-tensor. According to his view, in this provisional state of the theory, material bodies are essentially regions where his gravitational field-equations ($G_{\mu\nu} = 0$) are not satisfied, and so, in this sense, the bodies are singularities in the field. In 1938 and succeeding years, Einstein and his collaborators improved upon the original formulation of the theory to the extent of showing that the motion of such singularities in each other's presence is determined by the field-equations alone. Thus general relativity has no need to postulate equations of motion in addition to the field-equations, by reason of the non-linearity of the latter. However, Einstein's ultimate aim was to obtain field-equations such that actual physical systems correspond to solutions free from singularities. He believed this would be possible if, and only if, he could represent all physical forces, electromagnetic and nuclear as well as gravitational, in the theory—hence the name 'unified field theory'. If successful, such a theory would account for the existence of material particles in terms of the field and so, in the most fundamental manner that Einstein could envisage, it would reconcile these aspects of reality. In doing so, he further believed, it would reproduce 'quantum' effects, but without the need for the statistical interpretations to which he objected in current quantum theory. After various discarded attempts, he thought the field-equations which he proposed in 1949–51 to be "the most natural generalization of the equations of gravitation". Whether these equations possess solutions free from singularities has not yet been determined.

The problem of unifying the basic concepts of physics has, of course, the importance that Einstein thought. However, most physicists expect it to be solved rather by a generalization of quantum theory than by the opposite approach attempted by Einstein. His view and comments by its leading critics are to be found in "Albert Einstein: Philosopher Scientist" (edit. P. A. Schlipp, New York, 1949, 1951). Here it need only be said that Einstein's position should be judged only in the light of his doctrine of concepts as being "freely chosen conventions".

Besides the main development of his work, Einstein made numerous other important contributions. These include, for example, the 'Einstein coefficients' in connexion with atomic transition-probabilities, his work from which the Einstein–Bose statistics emerged, and his enunciation of the 'Einstein universe' and other contributions to relativistic cosmology.

Einstein was deeply and increasingly concerned about world affairs. In the First World War he took a courageous stand as a pacifist in Germany. However, he could not but approve of the war against Nazism, and in 1939 he sent a historic letter to the American President warning him that Germany might succeed in manufacturing an atomic bomb. He became a leading spokesman for Jews throughout the world, particularly in regard to their return to Palestine. He was for long an advocate of world government. His opinions on these matters and his attitude towards philosophy and religion are expressed in the collection of essays "Out of my Later Years" (New York and London, 1950).

Einstein's gifts inevitably resulted in his dwelling much in intellectual solitude. While he was not sociable in the usual sense, he had a penetrating understanding of his fellow-men. Music played a great part in his life, and the satisfaction it gave him he gladly shared with his friends. The many tributes paid to his personality all testify that his moral stature matched his intellectual pre-eminence.

W. H. McCrea

My first contact with Einstein was at the eighty-fifth meeting of the German *Naturforscherversammlung*, held in Vienna in September 1913, when I was a postgraduate student in the Radium Institute there. In his usual attractive and friendly manner, he lectured to the Physics Section on "Gravitation", and his lecture quite obviously impressed most of his hearers as the work of a master-mind. But it was clear in the discussion which followed that many German-speaking men of science were not yet converted to his ideas. Doubts were expressed on the validity of his views on the equality of inertial and gravitational mass, on the velocity of propagation of gravitational processes, on the possibility of ever being able to detect the deflexion of light rays in a gravitational field or the predicted red-shift of spectral lines in such a field. The over-riding impression left on my mind was that the older generation was more sceptical than the younger and, indeed, several of these young men, then in their

twenties, later became distinguished workers in special and general relativity. But throughout the discussion Einstein remained smilingly unperturbed and said he was prepared to stand or fall by the results of an empirical examination of his predictions. He had not very long to wait, for when I translated his popular work on "Relativity" in 1920, I suggested to him that he might like to include an appendix on the experimental confirmation of the theory and he immediately agreed, there being already much experimental evidence available in his support.

Having finished one piece of work, he rarely returned to it, preferring to investigate fresh fields. Once the original proofs of his popular book were sent to press, I think it unlikely that he ever re-read the text, contenting himself with adding new appendixes, the last of which appeared two years ago. Thus it was that a statement in the early editions, about the impossibility of testing empirically his mass-energy relation, remained uncorrected until two years ago, when, during proof-reading, I noted the oversight and was able to add a supplementary note to the relevant chapter.

His world-wide but unsought fame undoubtedly reached its zenith with the confirmation of his predicted gravitational deflexion of light rays by Eddington and others in 1919. This news caught the popular imagination and was a pleasant change from news of war. His first comments in Britain on the results of the solar eclipse expeditions were published at the request of *The Times*, rather than in a recognized scientific journal. Referring to this in a letter to me, he wrote: "It cannot do any harm, for, thank God, the solar eclipse and the theory of relativity have nothing in common with politics. In this work, English men of science have behaved splendidly throughout, and to my delight your letter shows me that the feelings of English colleagues have not been influenced as much by the war as one might have feared. Within the last few days I have had also from Eddington a very charming letter, about which I have been extremely pleased. I should like to utilize the favourable circumstances to contribute as much as possible towards the reconciliation of German and English colleagues". (My translation.)

I had been a civilian prisoner in Vienna throughout the First World War, but was allowed to continue my scientific work unhindered. Referring to this, Einstein wrote: "Your two letters have given me great pleasure and particularly the news that our Viennese colleagues treated you in such a friendly manner during the war". My next meeting with him was immediately after his lecture on relativity at the University of Manchester in 1921, when I had the pleasure of driving with Prof. and Mrs. Einstein and Dr. Erwin Freundlich in the environs of the city.

ROBERT W. LAWSON

NEWS and VIEWS

Linnean Gold Medal :

Sir John Graham Kerr, F.R.S.

THE award of the Linnean Gold Medal on May 24 to Sir John Graham Kerr has given great pleasure to a wide circle of colleagues and former students who have had the benefit of his stimulating and original personality, and also to a much wider circle of naturalists throughout the world. Sir John is one of the last of the great zoologists of the beginning of this century, who seemed to possess an almost encyclopædic general knowledge of the subject, as well as being a specialist in one or more branches. He started his career as a naturalist in the Linnean and Darwinian tradition, by joining an expedition to the Pilcomayo region of the Gran Chaco, Paraguay, during 1889–91. The years following this expedition were spent at Cambridge, where the School of Zoology then occupied an unrivalled position as a centre for the study of comparative morphology and embryology. He joined Christ's College as a scholar and after taking his degree carried out a second expedition to the Gran Chaco—during 1896–97—to study the little-known lung-fish, *Lepidosiren*. The account of these two famous expeditions—"A Naturalist in the Gran Chaco"—was only published in 1950 and has been described as the best book about South America since Charles Darwin's "Voyage of the Beagle". He was appointed regius professor of natural history in the University of Glasgow in 1902, when the chair still included geology—which, however, became distinct in the following year. He held the chair for thirty-three years and built up a great Department of Zoology and a very fine museum in which the exhibits were beautifully displayed on black backgrounds with indirect lighting. During these years, apart from his numerous publications and text-books, he took an active part in public affairs and became chairman of the Glasgow Unionist Association and afterwards represented the Scottish Universities as M.P., 1935–50. He originated and communicated to the Admiralty in September 1914 the scheme for the protective coloration of ships by counter shading and strongly contrasting patches ('dazzle') based on his observations in the field.

The president of the Linnean Society, Lieut.-Colonel Seymour Sewell, in presenting the Medal, recalled that when he entered Christ's College, Cambridge, fifty-six years ago, Sir John was then a Fellow of the College and demonstrator in the Department of Animal Morphology, and he also referred briefly to the many distinctions of "the doyen of British zoologists". The Medal was received on behalf of his father by Mr. Ronald Graham Kerr, and the meeting expressed its deep sympathy with Sir John in his blindness, which prevented his attendance, and also their warm affection for him, both as an eminent scientist and Fellow of the Society, and a personal friend of long standing.

Applied Geophysics at Imperial College of Science and Technology, London :

Prof. J. McG. Bruckshaw

As part of the expansion programme of the Imperial College of Science and Technology, London, an entirely new Department of Applied Geophysics has been established in an extension of the Royal School of Mines, where it will function in appropriate juxtaposition to the Departments of Geology and of Applied Geochemistry. In charge of the new Department will be the first occupant of the recently instituted chair of applied geophysics, Prof. J. McG. Bruckshaw, who has been largely responsible for instruction and research in geophysics within the

Imperial College for many years. Trained initially as a physicist under Sir Lawrence Bragg at the University of Manchester, he was attached by the Department of Scientific and Industrial Research in 1929 to the Imperial Geophysical Experimental Survey in Australia, where his interest in the use of physical methods of mineral exploration was first aroused. Two years later, on his return to England, he was enlisted by Prof. A. O. Rankine to help in setting up a school of geophysics within the Physics Department of the Imperial College, where it has continued to flourish progressively, especially during the past decade. His research activities have ranged far across the ever-widening field of geophysical prospecting, and he has enriched the literature by many pioneering contributions, notably on rock magnetism —a subject of profound academic and practical significance. Prof. Bruckshaw's diverse experience of geophysical surveys in many lands fits him well for the task of training students of geology and physics in the techniques of geophysical prospecting. At the same time, his intimate knowledge of field problems will enable him to direct research towards the twin goals of improved methods of subsurface exploration and of more reliable interpretations of geophysical anomalies. Under his guidance the Department of Applied Geophysics confidently expects to play an increasingly important part in providing skilled personnel to allay the growing demands of the mining and oil industries for help in the search for concealed mineral deposits at home and abroad.

Agriculture at Wye College, University of London: Prof. William Holmes

The University of London chair in agriculture at Wye College, vacant since the appointment of Prof. M. McG. Cooper to the chair in King's College, University of Durham, is being filled by Dr. William Holmes, who comes from Kilbarchan in Renfrewshire, and is still in his early thirties. He was educated at the John Neilson Institution in Paisley and then took the degree course in agriculture of the University of Glasgow and the West of Scotland Agricultural College. He graduated in 1942 after winning several College medals and prizes, including the Weir of Courance Prize in advanced agriculture and the distinction of being the most successful final-year student; in the same year he was awarded the College and National Diplomas in Dairying. After becoming farm manager at the Hannah Dairy Research Institute, Dr. Holmes took a leading part in the work of the Institute which established the practicability of producing high yields of milk under war-time and other conditions of self-sufficiency in feeding-stuffs. This work had other important results, including a study of efficient utilization of pasture, and a convincing demonstration that unprecedentedly heavy applications of nitrogenous fertilizer to a ley could be economic provided the rest of the soil treatment was kept in balance. Dr. Holmes gained his doctorate for his share in these investigations, which have much interest for all concerned with the rational intensification of use of grassland.

Institution of Mining and Metallurgy: Awards

The following awards have been made by the Institution of Mining and Metallurgy. *Gold Medal of the Institution:* Prof. W. R. Jones, past president of the Institution, in recognition of his services to the science of economic geology and to the Institution. *Honorary Membership of the Institution:* Sir Winston Churchill; Mr. G. A. Denny, in recognition of his distinguished services to the mining industry of the Union of South Africa, notably in the early development of Witwatersrand gold mines; and Dr. J. B. Tyrrell, in recognition of his work in the exploration and development of the mineral resources of Canada. *Consolidated Gold Fields of South Africa, Limited, Premium of Forty Guineas:* Mr. G. C. Norris, for his paper on some grinding tests with spheres and other shapes (*Trans. Inst. Min. Metall.*, **63**). *Arthur Claudet Student's Prize:* Dr. A. R. Barringer, for his paper on the preparation of polished sections of ores and mill products using diamond abrasives, and their quantitative study by point counting methods (*Trans. Inst. Min. Metall.*, **63**).

The Gold Medal which has been awarded to Prof. Jones is the highest honour the Institution can confer. Prof. Jones, who is seventy-five, was educated at the Imperial College of Science and Technology, London, and spent his early career abroad, first for four years in the Colonial Service as first assistant government geologist to the Federated Malay States, then in Burma during 1916–19 as general manager of High Speed Steel Alloys Mining Co., Ltd., and later as managing director of the Malayan China-Clay and Pottery Co. In 1926 he returned to the Imperial College to work in the Geology Department of the Royal School of Mines, being successively demonstrator, lecturer, reader and, in 1941, professor of mining geology. He retired in 1947, when he was made an emeritus professor, and in the following year he was made a C.B.E. An important feature of his work has been his investigations into the causes of silicosis and pneumoconiosis among miners in South Wales; more recently he has been active as chairman of a working party appointed by the Government in 1946 to revive the china-clay industry in Great Britain, and as a member of the Mineral Resources Committee of the Ministry of Fuel and Power. Prof. Jones's connexion with the Institution dates back to 1916 when he became an associate member; for the past twenty years he has served continuously on the Council, holding the office of vice-president for the three sessions 1939–42 and president for the session 1947–48.

Television Service in Band III

The first report of the Postmaster General's Television Advisory Committee (1952) made it clear that the future development of television services in Britain must take place in the higher bands of radio frequencies, of which Band III (174–216 Mc./s.) must be the first to receive attention. The Independent Television Authority has now announced that commercial television will start in London on September 22 from a transmitting station now being built at Croydon, Surrey, and designed to operate in Channel 9 (191–196 Mc./s.). The British Broadcasting Corporation has also ordered transmitting equipment for the provision of an alternative television service in Band III, and has applied to the Postmaster General for an allocation of channels in the Band.

In order to assist the manufacturers of television aerials and receivers to operate on the new frequencies coming into use in Band III, arrangements have been made by the Radio Industry Council, in co-operation with the Independent Television Authority, for test transmissions to take place from a temporary station near Croydon. These experimental transmissions are now being made by Belling and Lee, Ltd., during 1030–1230 hr. and 1400–1600 hr. on

Mondays to Fridays, and 1000–1300 hr. on Saturdays. A vision signal of a suitable test card is provided on a frequency of 194·75 Mc./s., using a radiated power of about 1 kW. from a temporary mast 85 ft. high, using vertically polarized transmission. While both the power and the height of the aerial to be used for the Independent Television Authority's service transmitter will be considerably greater than these values, it is considered that the signals obtained over a radius of 10–20 miles from this test transmitter should be of considerable assistance to all those concerned with the development of television in Band III.

Organization of Agricultural Research

THE organization of agricultural research in Britain has recently been reviewed by the Government. As a result, the grant-aiding function hitherto exercised by the Ministry of Agriculture, Fisheries and Food has been transferred to the Agricultural Research Council. The financial and general administration, as well as the scientific direction, of the grant-aided agricultural research institutes in England and Wales will therefore be unified under the Council. The independent status of the grant-aided institutes will not be affected. So far as Scotland is concerned, the Government has accepted the recommendation of the Royal Commission on Scottish Affairs and no change will be made in the present arrangements, under which grants-in-aid are made to certain agricultural research institutes by the Secretary of State for Scotland, on the advice of the Agricultural Research Council. The importance of linking agricultural research effectively with the needs of the agricultural industry is fully recognized. To this end an order will be submitted for the approval of Her Majesty in Council, reconstituting the Committee for the Privy Council for Agricultural Research, so as to consist of the Lord President of the Council and the two agricultural Ministers. Close attention will continue to be given to the co-ordination of the work of the Agricultural Research Council on one hand, and the Agricultural Improvement Councils of England and Wales and of Scotland on the other. These changes will, it is hoped, be completed by March 31, 1956.

Peaceful Uses of Atomic Energy : British Exhibitions at Geneva

DURING the International Conference on the Peaceful Uses of Atomic Energy to be held in Geneva during August (see *Nature*, April 9, p. 615), there will be an exhibition of equipment, etc. Great Britain will be represented by two collections of exhibits. One will be of a purely scientific character and intended principally for members of delegations. It is being arranged by the United Kingdom Atomic Energy Authority at the Palais des Nations, and will cover an area of 3,000 sq. ft. It will be mainly concerned with nuclear reactors for research and for the generation of power, and with specialized instrumentation which Britain has developed in this field. The second exhibition, in the Palais des Expositions, will be open both to delegations and to the general public. In an area of 5,000 sq. ft., the United Kingdom Atomic Energy Authority exhibits will provide a general survey of the peaceful applications of atomic energy in Britain. The subjects presented will include Britain's first atomic power station, now being built at Calder Hall; the ten-year power station programme; isotope applications in industry, medicine and agriculture; and nucleonics. Associated with this central feature will be exhibits presented by British firms concerned with atomic energy development. To co-ordinate the commercial exhibits, a central committee has been formed, under the chairmanship of Mr. Eric H. Underwood, director of public relations to the Atomic Energy Authority, and including representatives of the Federation of British Industries, the nucleonics industry, civil engineering contractors, boilermakers and manufacturers of electrical and generating equipment. Mr. N. C. Pratt (Philips Electrical, Ltd.) is acting as honorary co-ordinator to the commercial exhibition committee. Inquiries of a technical character should be addressed to Mr. E. H. Underwood at the United Kingdom Atomic Energy Authority, St. Giles Court, 1–13 St. Giles High Street, London, W.C.2.

Research in the Belgian Congo

AN illustrated brochure has been issued by the Institute for Scientific Research in Central Africa, founded at Leopoldville, Belgian Congo, on July 1, 1947, describing the functions and organizations of the Institute and its activities and achievements during its first five years (pp. 14+13 plates. Brussels: Institut pour la Recherche Scientifique en Afrique Centrale, 1955). Its first task is to encourage studies by research workers in Belgian Central Africa and scientific visitors to the Congo; but it is also responsible for co-ordinating scientific work in the area and making it more systematic. Up to the end of 1954 the Institute had built up a staff of forty Europeans and four hundred Africans, and a central library at the Lwiro Research Centre, on Lake Kivu, Bukavu, consisting of sixteen thousand volumes. Its three main fields of research are the physical, biological and human sciences. The latter embrace physical and social studies of the African, including his nutrition and physical aptitudes and characteristics, political organization, culture and economy. Physical research is concentrated at Lwiro and Mabali and includes astrophysical, solar radiation, geophysical and seismological studies, while biological work includes human nutrition and zoology at Lwiro, hydrobiology at Uvira, biochemistry at Elizabethville, and physiology and botany at Mbali.

Mount Everest

To the readers of any of the works on Mount Everest, a pamphlet in the form of a chart entitled "Everest: a Guide to the Climb", by James Champion (London: University of London Press, 1955; 1*s.* 6*d.*), should be welcome. It portrays the ascent of the mountain from 17,000 ft., indicating the main features of the route and the position of the camps. Mr. Campion has analysed the features of the climb clearly and comprehensively, and so has much increased the reader's appreciation of the almost insurmountable difficulties. The pamphlet also contains two pictorial sketch-maps of the topmost regions of the mountain, and there are short biographical notes on the climbers, including the Sherpas.

Beit Memorial Fellowships for Medical Research

BEIT Memorial Fellowships for Medical Research (junior fellowships worth £800 a year) have been awarded to the following for research at the institutions indicated: Dr. P. C. Caldwell, the mechanism of muscular contraction in Crustacea (Marine Bio-

logical Laboratory, Plymouth); Dr. R.-H. Côté, the chemical constitution of human blood group substances of the A, B and O Lewis systems (Lister Institute of Preventive Medicine, London); Dr. E. I. B. Dresel, the biosynthesis of porphyrin pigments (University College Hospital Medical School, London); Dr. J. M. Lowenstein, the biosynthesis of pyrimidines in mammals (Department of Biochemistry, University of Oxford); Dr. R. Whittam, the metabolism of adenine nucleotides in relation to the active transport of inorganic ions (Physiological Laboratory, University of Cambridge).

Bowen Prizes for Papers on Scientific Instrumentation

The Institute of Physics has awarded Bowen Prizes to the following for papers published in the *Journal of Scientific Instruments* during 1954: Dr. K. P. Norris, of the Wheatstone Physics Laboratory, King's College, London (a reflecting microscope for infra-red absorption measurements); G. Revesz, of the British Rayon Research Association, Manchester (an autocorrelogram computer); and J. H. Welch, of the Building Research Station, Watford (a simple microscope attachment for observing high-temperature phenomena). The first award is worth 20 guineas, and the other two 15 guineas each, the money being provided by the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., from the Bowen Trust Fund established by the late Mr. William Bowen. The Prizes are open to authors who are not more than thirty-five years of age.

Nuclear Physics: Summer Course at Lake Como

The third of the annual courses arranged by the Italian Physical Society at the Ente Villa Monastero, Varenna, Lake Como, will be held this year during July 17–August 6 and will be on nuclear physics. The course, which will be under the direction of Prof. C. Salvetti (University of Milan), will be in English and French, and lectures will be given by the following: Prof. A. Bohr (University of Copenhagen); Prof. S. de Benedetti (Carnegie Institute of Technology, Pittsburgh); Prof. G. Placzek (Institute for Advanced Study, Princeton); Prof. I. I. Rali (Columbia University, New York); and Dr. A. M. Weinberg (research director at the Oak Ridge National Laboratory). The number of students is limited to thirty, and the fee for the course is 25,000 lire (or 20,000 lire for shared accommodation). Application must be made before June 10 to Prof. C. Salvetti, Società Italiana di Fisica, Via Saldini 50, Milano.

The Night Sky in June

Full moon occurs on June 5d. 14h. 08m., U.T., and new moon on June 20d. 04h. 12m. The following conjunctions with the moon take place: June 3d. 09h., Saturn 6° N.; June 18d. 19h., Venus 3° S.; June 21d. 11h., Mars 3° N.; June 22d. 12h., Jupiter 4° N.; June 30d. 12h., Saturn 6° N. In addition to these conjunctions with the moon, Venus is in conjunction with Aldebaran on June 21d. 11h., Venus 4·6° N., and Mercury is in conjunction with Venus on June 30d. 08h., Mercury 3·8° S. Mercury sets at 21h. 35m. on June 1, but is too close to the sun for favourable observation during most of the month and is in inferior conjunction on June 16. Venus rises at 3h., 2h. 45m. and 2h. 40m. on June 1, 15 and 30, respectively, its stellar magnitude remaining −3·3 throughout the month; although the visible portion of its illuminated disk increases from 0·906 to 0·954, the stellar magnitude does not vary owing to the planet increasing its distance from the earth by 11 million miles. Mars sets at 22h., 21h. 40m. and 21h. 15m. on June 1, 15 and 30, respectively, but towards the middle of the month it is too close to the sun for favourable observation. Jupiter sets at 23h. 20m., 22h. 30m. and 21h. 40m. at the beginning, middle and end of the month, respectively; at the end of the month it sets less than an hour and a half after sunset and cannot be observed for long. Saturn sets in the early morning hours at 3h. 05m., 2h. 15m. and 1h. 10m. on June 1, 15 and 30, respectively, and has a retrograde motion in the constellation Libra. No occultations of stars take place in June which are visible at Greenwich. Summer solstice occurs on June 22d. 05h.

On June 20 a total eclipse of the sun takes place, which is invisible in the British Isles. The path of totality crosses the Indian Ocean, Ceylon, Thailand and the Philippines, and is total at Colombo, where it begins on June 20d. 01h. 37m. and ends at 3h. 59m., the total eclipse lasting from 2h. 40·7m. to 2h. 44·9m. The period of totality near the Philippines is about 7m. 08s., which is close to the maximum duration that is possible; it is the longest time of totality that has occurred or will occur in this century.

Announcements

Prof. W. H. Bucher, professor of structural geology in Columbia University, New York, has been awarded the William Bowie Medal of the American Geophysical Union (the Committee on Geophysics of the National Research Council) for his work in the field of structural geology and mountain building. Prof. Bucher is the seventeenth recipient of the Medal, which was first awarded in 1939 to the late William Bowie, the geodesist and geophysicist, in whose honour the Medal is named.

Dr. E. W. Russell, reader in soil science, Department of Agriculture, University of Oxford, has been appointed director of the East African Agriculture and Forestry Research Organization, in succession to Sir Bernard Keen, who has retired (see *Nature*, January 29, p. 194).

The following appointments have been made in the University of Leeds: Dr. E. R. Clark, lecturer in pharmacological chemistry in the Department of Pharmacology; Dr. P. G. Harris, lecturer in geology; and Mr. F. Summers, senior research worker in the Department of Social Studies for two years under the terms of a grant from the Coal Industry Social Welfare Organization.

Mr. M. W. Partridge, at present lecturer in pharmaceutical chemistry in the University of Nottingham, has been elected to the Lord Trent readership in pharmaceutical chemistry in the University.

The symposium on the tanning industry of eastern India and on tanning agents, which was to have been held this year at the Central Leather Research Institute, Adyar, Madras 20, during February 8–9, had to be postponed and will now be held during July 6–8. In the discussion on tanning agents the field will cover vegetable, synthetic, mineral, oil and aldehyde tanning agents. Advance copies of papers must be sent in by June 16. Further information can be obtained from the Director of the Institute.

THE U.S. NATIONAL ACADEMY OF SCIENCES

ANNUAL MEETING

THE ninety-second annual meeting of the National Academy of Sciences was held in Washington, D.C., during April 25–27 and was attended by more than two hundred members and their guests, with Sir K. S. Krishnan, president of the National Institute of Sciences of India and director of the National Physical Laboratory, New Delhi, as the guest of honour. Thirty-five papers were read at five sessions. Three other sessions were devoted to symposia on the following subjects: sound and its perception; biochemical pathways of energy transfer; and modern concepts in meteorology.

At the meeting the following awards of the Academy were presented: *Agassiz Medal*, to Prof. W. Maurice Ewing, director of the Lamont Geological Observatory and professor of geology at Columbia University, New York; *Elliot Medal*, to Dr. Libbie H. Hyman, research associate of the American Museum of Natural History, New York; *J. Lawrence Smith Medal*, to Dr. Peter M. Millman, head of the Section on Upper-Atmosphere Research of the Division of Radio and Electrical Engineering, National Research Council of Canada; and *Kimber Genetics Awards*, to Prof. William E. Castle, emeritus professor of genetics, Harvard University, and Prof. Hermann J. Muller, professor of zoology, Indiana University.

The Alexander Agassiz Medal, which is open to anyone for outstanding work in the science of oceanography, has been awarded to Prof. Ewing for his achievements in marine geophysics. During the Second World War he worked on underwater explosives and also on a system of long-range underwater sound transmission; more recently he has made important contributions to knowledge of the structure of the floor of the Atlantic Ocean and the continental shelf, and his underwater photographic techniques have greatly increased knowledge of conditions on the ocean floor in deep water.

The Elliot Medal, which is for the most meritorious work published each year in zoology or palæontology, has been awarded to Dr. Hyman for her two volumes, published in 1951, which are part of a treatise on "The Invertebrates", and are important not only to zoologists but also to teachers and to research workers concerned with medical matters, especially parasitism. Dr. Hyman is the first woman to receive this award since it was established in 1917, and is the second woman to gain an Academy medal.

Dr. Millman, who receives the J. Lawrence Smith Medal for "fruitful research in meteoric bodies", is a pioneer in the application of radar to the detection of meteor showers; his earlier work on the spectra of incandescent meteors has contributed much to our knowledge of the earth's atmosphere.

The Kimber Genetics Awards, which are being presented for the first time this year, have been established by the Kimber Farms Foundation of Niles, California, to recognize distinguished scientific contributions in the field of genetics, either through single accomplishments of unusual significance or through a long period of significant productivity. Dr. Castle, who is eighty-seven, was one of the first workers in the United States to study mammalian genetics; near the turn of the century his research showed decisively the role of what we now know as genes as the mechanisms by which inherited characteristics are transmitted. Dr. Muller's most important contributions to genetics have been his studies of the genetic effects of radiations, work which has shed much light on the structure and function of the chromosomes; he was awarded the Nobel Prize for Physiology and Medicine in 1946.

The following new elections were made to the Council of the Academy: *Home Secretary*, Dr. Hugh L. Dryden, director of the National Advisory Committee for Aeronautics, Washington, D.C.; *Members of Council*, Dr. E. A. Doisy (St. Louis University School of Medicine), Dr. Theophilus S. Painter (University of Texas) and Dr. James Gilluly (United States Geological Survey, Denver, Colorado). The other officers of the Academy, who were elected in previous years and will continue until the expiry of their terms of office, are as follows: *President*, Dr. Detlev W. Bronk; *Vice-President*, Dr. George W. Corner; *Foreign Secretary*, Prof. John Gamble Kirkwood; *Treasurer*, Dr. William J. Robbins; *Members of Council*, Prof. Farrington Daniels, Dr. Hugh L. Dryden, Dr. Robert F. Loeb, Prof. Wendell M. Stanley, Dr. Merle A. Tuve and Prof. Edwin B. Wilson.

The following have been elected members of the Academy: W. F. Albright, professor of Semitic languages, Johns Hopkins University; L. R. Blinks, professor of biology, Stanford University, and director of the Hopkins Marine Station, Pacific Grove, Calif.; R. D. Brauer, professor of mathematics, Harvard University; H. S. Brown, professor of geochemistry, California Institute of Technology; R. K. Burns, staff member, Carnegie Institution of Washington; S. Chandrasekhar, professor of theoretical astrophysics, Yerkes Observatory, University of Chicago; J. Chipman, professor of metallurgy, Massachusetts Institute of Technology; C. S. Coon, curator of ethnology, University Museum, University of Pennsylvania; R. Courant, professor of mathematics and director, Institute of Mathematical Science, New York University; G. Dalldorf, director of the Division of Laboratories and Research, New York State Department of Health; P. H. Emmett, senior fellow, Mellon Institute, Pittsburgh; R. W. Gerard, professor of neurophysiology, Neuropsychiatric Institute, University of Illinois; K. Gödel, professor of mathematics, Institute for Advanced Study, Princeton; R. G. Herb, professor of physics, University of Wisconsin; J. Holtfreter, professor of zoology, University of Rochester; M. K. Hubbert, research geologist, Shell Oil Company, Houston, Texas; N. J. Leonard, professor of chemistry, University of Illinois; C. M. MacLeod, professor of microbiology, New York University College of Medicine; H. W. Magoun, professor of anatomy, University of California Medical Center, Los Angeles; D. Montgomery, professor of mathematics, Institute for Advanced Study, Princeton; P. McC. Morse, professor of physics, Massachusetts Institute of Technology; J. R. Pierce, director of electronics research, Bell Telephone Laboratories, Inc.; C. P. Smyth, professor of chemistry, Princeton University; E. E. Snell, professor of chemistry, University of Texas; K. W. Spence, professor of psychology, State University of Iowa; G. E. Uhlenbeck, professor of theoretical physics, University of Michigan; R. C. Williams, professor of biophysics and biophysicist to the Virus Laboratory, University of California,

Berkeley; D. W. Wilson, professor of physiological chemistry, School of Medicine, University of Pennsylvania; P. W. Wilson, professor of bacteriology, University of Wisconsin; and S. Winstein, professor of chemistry, University of California, Los Angeles.

The following have been elected foreign associates of the Academy: Prof. Max Born, formerly professor of physics in the Universities of Göttingen and Edinburgh; Dr. Bertil Lindblad, director of the Stockholm Observatory; Dr. André Lwoff, head of the Department of Microbial Physiology, Institut Pasteur, Paris; and Sir Alexander Todd, professor of chemistry in the University of Cambridge.

TWELFTH GENERAL ASSEMBLY OF THE INTERNATIONAL UNION OF BIOLOGICAL SCIENCES

THE International Union of Biological Sciences held its twelfth General Assembly in the rooms of the Consiglio Nazionale delle Ricerche in Rome during April 11–16. The following nineteen countries were represented by delegations: Belgium, Canada, Czechoslovakia, Denmark, Egypt, France, German Federal Republic, Great Britain, India, Israel, Italy, Japan, The Netherlands, Norway, Sweden, Switzerland, Union of South Africa, United States, Yugoslavia.

At the previous General Assembly, held at Nice in August 1953, the Assembly appointed a Policy Board, under the chairmanship of Prof. Paul Weiss, to advise the Bureau on the future scope and structure of the Union. The Policy Board met in Paris during July 1954, and made a series of recommendations which the Bureau laid before the General Assembly at Rome for discussion and subsequent adoption in statutory form.

Here lay the chief task of the twelfth General Assembly, and it was clear that the national delegations had come determined to set the affairs of the Union on a new foundation. Under the inspired chairmanship of Prof. Sven Hörstadius, the Assembly did indeed create a new body within the framework of a completely fresh set of statutes. The Union is now organized in three divisions, namely: Botany (Plant Biology); Zoology (Animal Biology); General Biology. Each division is composed of a number of sections, not necessarily corresponding to the sections of the old Union. On the contrary, the statutes now lay down that "No section shall be accepted unless its admission is requested by a recognised International Association in the discipline it professes; or by at least six National Committees which include representation of that discipline". This means that in future each section will be truly representative of the workers in the particular field of biology it claims to cultivate.

In the new administrative structure, the small Bureau of the old Union disappears. There are now only two organs, the General Assembly and the Executive Committee. The Executive Committee consists of the officers of the Union together with two representatives from each division. The following persons were unanimously elected at Rome on the recommendation of a nominations committee appointed by the General Assembly: *President*, Sven Hörstadius (Sweden); *Vice-President*, R. E. Cleland (U.S.A.); *Secretary-General*, G. Montalenti (Italy); *Treasurer*, J. Lanjouw (The Netherlands); *Secretary*, R. Ulrich (France). Division of Botany: P. Chouard (France), J. Rousseau (Canada); Division of Zoology: E. Handschin (Switzerland), B. Rensch (German Federal Republic); Division of General Biology: A. A. Miles (Great Britain), P. Gaillard (The Netherlands).

The new Executive Committee plans to meet in London in November 1955. London will also be the venue of the next General Assembly in 1958, to be held immediately prior to the Zoological Congress already planned for July of that year.

The General Assembly adopted two important resolutions. The first of these supports the resolution passed by the International Council of Scientific Unions a year ago underlining the potential danger to deep-sea research of the draft articles on the continental shelf framed by the International Law Commission of the United Nations. The second concerns the radiation hazards of large-scale fission and thermonuclear experiments, and the problem of the disposal of atomic waste. The International Union of Biological Sciences urges the immediate need of a special committee of the International Council of Scientific Unions to report on these matters. This second resolution will be considered by the forthcoming General Assembly of the Council at Oslo in August 1955.

Other business carried out by the Assembly included the following items: The admission of Scientific Psychology as a Section in the Division of General Biology, on the request of the competent bodies in Brazil, Belgium, France, Spain, Switzerland, Japan and the United States. Responsibility for the Type Culture Collections is to be delegated to the Executive Committee of the International Association of Microbiologists, with a recommendation that precedence should be given to specialized collections of micro-organisms in allocating subventions drawn from Unesco. A Commission on Photo-Biology in the Division of General Biology was established. It was decided to send an observer to the forthcoming meeting of the Executive Committee of the ICSU Abstracting Board at Zurich in July 1955. Dr. Anton Bruun (Copenhagen) was appointed to the Special Committee of the International Council for the International Geophysical Year 1957–58. Applications from the International Unions of Biochemistry and of Physiological Sciences for admission to the International Council of Scientific Unions are to be supported. The Union also decided to support the movement to increase the annual payments to the International Council of Scientific Unions.

An important symposium on "Topics of International Concern in the Life Sciences" was held during the week of the Assembly.

NEW ENGINEERING BUILDING FOR THE UNIVERSITY OF SHEFFIELD

THE opening of the new Engineering Building for the University of Sheffield on April 27 by the Minister of Defence, Mr. Selwyn Lloyd, marks the realization of long-planned developments in the engineering departments of the University. By 1945 the University's engineering buildings had become inadequate, even for the equipment then installed, and no more students could be accommodated,

though the nation's need for more engineers called for a large expansion both in student numbers and in training facilities. So, under the enthusiastic leadership of Prof. H. W. Swift, the Departments of Engineering were completely replanned to provide for about three times the pre-war number of students and for the equipment that they and an enlarged staff would need for teaching and research.

The new building stands on sloping ground on the north side of the St. George's Square site, and has a volume of nearly one and a half million cubic feet. It has three main floors, which are continuous with corresponding floors of the existing buildings. These are on the site of the old Sheffield Technical School, where the Department of Engineering was already well established so long ago as 1889.

The new building, which was begun in 1950 and is now in full use, houses the whole of the Department of Civil Engineering and most of the Department of Mechanical Engineering which, however, still retains some rooms in the old building. The Department of Electrical Engineering is thus able to expand in the old building, though it also has some rooms in the new building. Accommodation is thus provided in the three engineering departments for an annual intake of about ninety engineering undergraduates and about twenty postgraduate research workers, as well as for courses in engineering subjects for other technologists.

The cost, nearly £500,000, of the extensions has been provided largely from Government sources; but many generous donors have also contributed.

In general, the planning of the new building and the allocation of its rooms have been based on functional considerations. On the bottom or *A* floor are those laboratories requiring heavy equipment, considerable headroom or under-floor services. The sloping nature of the site made it possible to provide considerable headroom in these laboratories, which house large equipment, and also to provide a sub-ground floor containing a basement hydraulics laboratory and the heating boilers, electric sub-station and other services for the whole of the Applied Science Buildings. On the top or *C* floor are lecture rooms, drawing offices and most of the work-rooms. On the intermediate *B* floor are the laboratories containing light-weight apparatus, a photographic suite, a few work-rooms and a museum which already contains a collection of objects of historic interest to engineers. Private rooms for staff are provided on both *B* and *C* floors and along a mezzanine corridor. Lecture rooms and laboratories have been located on the south side of the building, as far away as possible from street noises.

Two of the five new lecture rooms have been planned to meet the needs of professional bodies and technical societies which hold their meetings in the Applied Science Building. These lecture theatres have capacity for audiences of 200 and 100, respectively, and are provided with complete demonstration services and projection equipment, adjacent ante-room, cloak room and other conveniences.

The system of student work-rooms is a feature of the new building and of the type of curriculum for which it has been planned. In a non-residential university, it is specially important that every student should have a place where he can go for private study at any time, day or evening, when he is not receiving formal instruction, and where he can obtain tutorial assistance or discuss his work with other members of his own group. In the new building there is a work-room for each group of students, and a work-table and locker for each individual student. A work-room can be used as a drawing office and lecture room for its own particular group.

The photographic needs of all three Departments are met in a suite of small rooms arranged along both sides of a safe-lighted corridor, so that individual students can gain experience in technical photography. The processes available include all the standard types of photographic copying, enlarging, slide preparation, photo-elasticity, record and micro-film reading and projection.

While the new building was being designed and built, extensive new equipment for the laboratories was being purchased, or designed and made in the engineering workshops, so as to meet the future needs of the reorganized departments. Much old equipment has also been improved and adapted to the requirements in the new laboratories. It is impossible to describe fully here the various laboratories and their equipment, though a few points regarding their design and layout may be mentioned.

With a few exceptions, the laboratories have been planned and equipped for both teaching and research, since most of the equipment and services are required for both purposes and since the laboratories are usually required for formal class-work for only a small proportion of the total working hours. Cranes and runways are fitted in most of the major laboratories on *A* floor, and easy access for heavy equipment is provided from an approach road at the back of the building.

Large civil engineering laboratories are provided on *A* floor for hydraulics, concrete technology and structures. Each of these has a floor area of about 3,400 sq. ft. and is 22 ft. high. A feature of the Concrete Technology Laboratory is the provision of two inner rooms in which concrete specimens may be cast and cured under constant atmospheric conditions. In the Hydraulics Laboratory, the machines and flow-systems are arranged so that experiments on them can be carried out simultaneously without mutual interference. Laboratories for Soil Mechanics and Light-weight Structures are provided in the civil engineering section on *B* floor.

The Electrical Engineering Department is being enlarged and reconstructed in the old building, as previously mentioned. In the near future, when these alterations are complete, seven electrical laboratories will provide for experimental work on electrical machines and power utilization, communications and electronics and measurements of standards. Two of these laboratories will be reserved for postgraduate work. Particular attention has been paid to accommodating the maximum number of students in these laboratories, and various novel features have been incorporated to minimize the floor-space required by equipment in order that each student shall have reasonable room to work.

Laboratories in the Mechanical Engineering Department are provided on *A* floor for the study of materials testing, machines and heat engines. On *B* floor there are laboratories for applied heat and metrology, and two rooms of the old building are being reconstructed to provide the first-year Mechanics Laboratory. An essential feature in planning these laboratories has been flexibility in arrangement and equipment. Services, foundations and fixing facilities have been designed to permit easy interchange of plant and apparatus without any interference with the building fabric.

The construction of the Heat Engines Laboratory presented many special problems. The power-units are effectively insulated from the building fabric. Airborne noise is reduced by using sound-absorbing tiles on parts of the walls and a special ceiling finish. All services are taken under the operating floor and connected to the engine beds with vibration-proof flexible connexions.

The new laboratories and their equipment, besides providing greatly enhanced teaching facilities, have much increased the potentialities for research in the three engineering departments.

This article is mainly concerned with the new building; but brief mention of the present undergraduate courses in engineering may be of interest. Since 1948 the degree courses in engineering have occupied three post-intermediate years for all students, and students are only admitted to the courses when they have reached intermediate standard in the essential preliminary subjects. There is no official intermediate course in engineering; but students not already qualified at this level can be admitted to preliminary courses in intermediate subjects. During the first (post-intermediate) year, all engineers follow a common curriculum in mathematics and applied science subjects, and this continues into the second year with some specialization for civil engineers. Honours and ordinary groups are separated in each Department after the examinations at the end of the second year, and the final-year courses are effectively specialized in content as between departments and distinct in type as between honours and ordinary groups in each Department. An essential part of the final course is a project, either an investigation, design or analysis, giving the student opportunity to develop his individual ability and initiative.

FORESTRY RESEARCH IN GREAT BRITAIN

THE report of the Forestry Commission for the year ending March 1953* is divided into two parts, the first detailing work carried out by the Commission's forestry research staff, and the second discussing research undertaken for the Commission by workers attached to universities and other institutions. In the section dealing with seed investigations, it is reported that the first 795 germination tests were undertaken, one-fifth of the tests being carried out by the tetrazolium vital-staining technique. An interesting point about seed storage is that it has been shown that acorns can be stored in moist peat for two years with little loss in viability, and beech mast for eighteen months. Various methods are being tried of improving derelict woodlands, many of them old coppice or coppice with standards, neglected since, with certain exceptions, the coppice is no longer a remunerative crop. In this work, different degrees of intensity of planting are being compared, from complete planting of cleared areas, to enrichment of existing regrowth using single large plants. On suitable sites the use of conifers in mixture with hardwoods to give earlier returns is being tried.

Under forest entomology, surveys of sawflies in spruce and larch crops were continued from previous seasons. It is becoming evident that foresters in Britain will have to deal with a different lot or type of forest insect pests as compared with the better-known ones so long studied on the Continent of Western Europe. Notable work has been undertaken in Great Britain since the introduction of machinery. Forest conditions are very different from Continental ones, especially in the prevalence of wet ground (even in a dry season on soft forest soils); ploughing work, fire protection and so forth are different. These troubles have led to considerable research and improvement in forest machinery of different types.

Part 2 of the report deals with research work in universities and institutions (such as Rothamsted, for example). Financial assistance is usually given from the Forestry Fund, and some help is provided in carrying out field-work by the Commission's research staff. The work detailed in the report is mainly in connexion with investigations into forest soils.

Large-scale planting of trees on peat is a comparatively recent thing in British forestry, and Bulletin No. 22 of the Forestry Commission deals with "Experiments in Tree Planting on Peat"*. Though during the past century private landowners made numerous attempts to establish plantations on peat land, failures were numerous on the more difficult types of peat, namely, the deeper ones. At this period successful plantations had been established in Russia on peat up to 10–12 ft. in depth. The procedure was to dig drains 3 ft. deep, two or three years later to deepen the drains another 3 ft., and then repeat the operation as necessary after another similar period. Scots pine or spruce seed would then be sown in small pockets, often with some birch, on the top layer of the dried peat. In those days they had plenty of time and unlimited land to choose from; but fifty-year old plantations showed fine development. In Britain and during the present century, more species have been available, such as sitka spruce, Japanese larch and *Pinus contorta*. Perhaps it is not surprising that the private landowner in Britain, quite untrained in forestry, was unacquainted with the early work in peat-planting on turves being undertaken by the Belgians. It was not until 1907 that Sir John Stirling Maxwell first adopted the method at Currour in Inverness-shire, and this laid the foundation for most of the subsequent successful developments in the afforestation of peat. The Belgian method did not entirely fulfil all requirements, and it was not until 1926–27 that 'mound' planting (as it was then called) in peat, sitka being one of the chief species used, was done; then the Commission brought into use, to save the high cost of turf digging, the plough, and the Commission developed this technique in an amazing fashion to tackle any utilizable depth of peat. It had been realized before the Second World War, in which little work of this type could be done, that periodical cleaning and deepening of the drains on peat types are essential to the good growth of the crop.

Paper No. 31 of the Imperial Forestry Institute, University of Oxford, by Dr. L. Leyton, deals with "The Growth and Nutrition of Spruce and Pine in Heathland Plantations"†. Experiments begun in

* Forestry Commission. Report on Forest Research for the Year ending March 1953. Pp. vi+122+9 plates. (London: H.M.S.O., 1954.) 5*s.* net.

* Forestry Commission. Bulletin No. 22: Experiments in Tree Planting on Peat. By J. W. L. Zehetmayr. Pp. iv+110+16 plates. (London: H.M.S.O., 1954.) 10*s.* net.

† Imperial Forestry Institute, University of Oxford. Institute Paper No. 31: The Growth and Nutrition of Spruce and Pine in Heathland Plantations. By L. Leyton. Pp. 109+7 plates. (Oxford: Imperial Forestry Institute, 1954.) 12*s.* 6*d.*

1949 on the growth of sitka spruce and Corsican pine (Wykeham, Allerston Forest, Yorkshire) and of the sitka spruce and Scots pine (Clashindarroch, Aberdeenshire) have now been completed and certain conclusions have been drawn. The most important limiting factor affecting the growth of spruce in the Yorkshire plantations is a deficiency in the available nitrogen. An increase in the growth of the trees can be obtained, at least temporarily, by removing the heather vegetation around the trees (screefing). Other more expensive measures may be undertaken. In the absence of the heather, when nitrogen is no longer deficient, calcium tends to become a limiting factor. In the Clashindarroch plantation, nitrogen and calcium are both deficient; but manganese may also play an important part, since screefing and heather mulching employed to stimulate growth may also lead to an increase in the manganese concentration in the needles. Both Scots and Corsican pines appear to be less affected than spruce by mineral nutriment deficiencies in the heathland soils, though in the latter case the removal of the heather also effects an improvement in the nitrogen status of the trees in their stimulation to growth. As may be expected, the removal of the ground vegetation during periods of dry weather may lead to excessive desiccation of the upper layers of the soil and thus affect the shallow-rooted spruce, a difficulty well known to foresters who undertake such work in tropical countries with shallow-rooted species.

E. P. Stebbing

WOOL INDUSTRIES RESEARCH ASSOCIATION

REPORT FOR 1954–55

THE report of the director of research of the Wool Industries Research Association, Dr. A. B. D. Cassie, for 1954–55* refers to the development of ion-exchange methods of analysing liquids which contain soap, fatty acid and wool grease and its extension to the analysis of solutions with anionic, cationic and non-ionic detergents and wool grease; in particular, emulsions of 'Lissopol *N*' with soap and grease can be separated quantitatively. The glass-type of apparatus for the rapid extraction of soap and grease from wool has now been superseded by an all-metal type. The automatic controller for the woollen card has now proved successful in a number of mills; this is part of a general programme on carding to determine how far a card may be simplified without reducing the quality of its product. The main obstacle to reduction of the number of cylinders on a card appears to be the removal of neps. Results with the pilot worsted drawing and spinning plant have emphasized so much the importance of machine settings that work is now proceeding on methods to determine the optimum settings for any lot of wool.

Much work has been carried out on the best regain and relative humidities for drawing and spinning wool, as well as on the weaving process and on the effects caused by the tension variations that can arise as yarn is pulled from cops or pirns as in the loom shuttle. Work on mothproofing has indicated the conditions of application that lead to adequate absorption of the moth-proofing agent by the wool and has also shown that application at lower temperatures gives lower resistance to washing. Further studies have been made of the continuous scouring of worsted yarn with synthetic detergents and soap, and of the effect of dyeing processes on the properties of wool, including the use of liquor containing ammonium salts. In the Scottish Laboratory a major cause of the variation in length of yarn wound on per draw of mule has been identified and eliminated. In biology, radioactive materials show considerable promise for examining the processes in the follicle that lead to the formation of fibres. The amino-acid composition of a homogeneous sample of Australian Merino 64's quality wool has been determined, as well as the lanthionine contents of wools which had received alkali treatment, and a new method for cystine analysis has been devised. Work on the generation and dissipation of static electricity is now being applied to separate static and adhesion forces so far as fibre pick-up on rollers is concerned.

At the thirty-sixth annual general meeting of the Association on March 29, when Dr. Cassie's report was presented, the chairman, Mr. J. F. Beaver, referred also to the close liaison maintained with the Work Study Centre of the Wool and Allied Textile Employers' Council in the detailed investigation of the relative merits of the automatic and non-automatic looms. Mr. Beaver also stressed the continued development of the Association's educational activities, particularly in regard to the dissemination of information about the research work of the Association. He remarked on the support given to the Morley Careers Exhibition, held during February 2–9 last, with the object of assisting recruitment of laboratory assistants and also of demonstrating the industry's interest in research. In addition, he referred to the International Conference on Wool Research to be held in Australia this summer at the invitation of the Commonwealth Scientific and Industrial Research Organization (see *Nature*, April 16, p. 667), at which the Association will be represented.

* Wool Industries Research Association. Report of the Director of Research for 1954–55. (W.I.R.A. Publication No. 201.) Pp. 31. (From the Association, Leeds, 1955.)

UNIVERSITY COLLEGE, LONDON

ANNUAL REPORT FOR 1953–54

IN the annual report of University College, London, for 1953–54, the chairman of the College Committee, Lord Cohen, and the Provost discuss the progress of the College during the present quinquennium.

In the early years of the quinquennium, departments had to reduce their requirements for new equipment to a degree that threatened in some instances the proper progress of their advanced work and research; the situation has now been so restored that, in spite of stringency, it has been possible to undertake a useful programme for the supply of capital equipment. Further, the institution of a modest number of new posts has been possible and some long-awaited developments have been realized. Thus, while the session has still been one of consolidation, it has also been one of encouraging progress.

This was made possible largely by the increase made through the Court of the University in the grant from the University Grants Committee and the Home Counties. In 1952–53 this had amounted to

£815,000 and was increased in 1953–54 to £862,000. Details are given of the support which the College has received from the great foundations, research councils, and from industrial organizations for various research activities.

The Faculty of Arts commemorated two events which registered its contacts with humanistic studies over the past century. In April 1954 the Classical Association celebrated its jubilee meeting in the College. The other event has a national, or possibly an international, importance that extends beyond its reference to the Faculty of Arts. On September 22, 1954, the restored Mocatta Library and the Gustave Tuck Theatre were opened in the presence of a large gathering of members of the College and of the Jewish Historical Society.

In the Faculty of Science the most valued development was the occupation of the new block of the Department of Physics. A special honours degree in biochemistry has been instituted, the College being the only school of the University to offer courses for such a degree. The total number of students at the College has increased from 3,441 in 1952–53 to 3,551 in 1953–54. The College has in all 743 postgraduate and research students and it has developed its tradition for making special provisions for this ever-increasing though widely scattered part of the College community.

The general impression made by the session has been that the post-war period under which the College suffered so severely is drawing to an end. This is encouraging since some departments are still inadequately housed and others are in urgent need of development.

GROWTH OF MUSCLE FIBRE IN THE FŒTAL SHEEP

By D. M. JOUBERT

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GROWTH of muscular tissue is generally accepted as occurring by hyperplasia during the embryonic and early fœtal stages, and essentially by the hypertrophy of existing fibres in late pre-natal and throughout post-natal life. With regard to the latter aspect of the problem, Schäfer[1] estimated the enlargement of the muscle fibre from mid-fœtal life until birth to be 200 per cent and, in some instances, 300–400 per cent, compared with a five-fold increase from birth to adult life. However, in their recent review of the subject, Adams, Denny-Brown and Pearson[2] state that previous attempts to measure cross-sectional diameter of muscle fibres at different stages of fœtal life have not yielded uniform results. It would appear that the most detailed investigation to date is that of Cuajunco[3], who measured formalin-fixed fibres of human specimens. His measurements showed a gradual change from 9 to 16μ for the largest, and from 5 to 7μ for the smallest fibres from the tenth week to full-term.

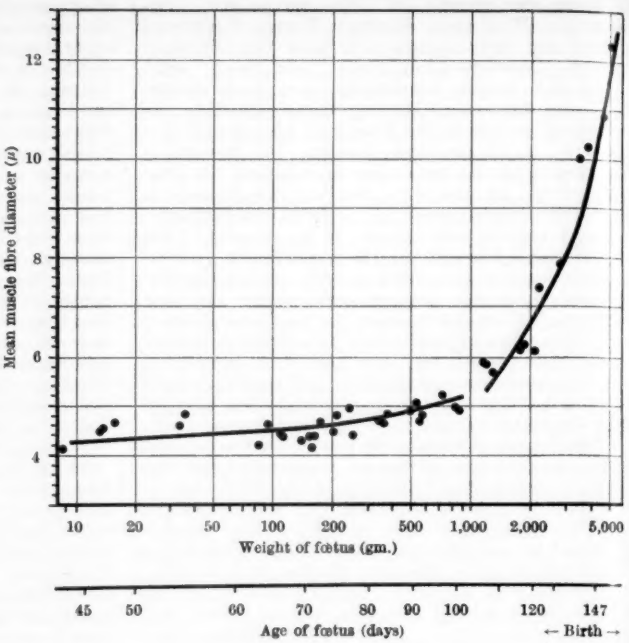

Fig. 1

During the course of investigations on pre-natal growth of the ovine fœtus, the cross-diameters of formalin-fixed muscle fibres were measured by means of an ocular micrometer at a magnification of × 420. Of each of forty-one specimens, ranging in age from 43 days to birth, 150 fibres were measured; fifty per muscle for the M. longissimus dorsi, M. rectus femoris and M. gastrocnemius lateralis. The mean values arrived at for the individuals studied, plotted against fœtal weight, are shown in Fig. 1. Though a time-scale is provided, weight has been chosen as the criterion of muscle-fibre development since the latter variate is more closely correlated with body-weight than with chronological age[4].

The results indicate that the fœtal muscle fibre undergoes but little change in diameter from a weight of approximately 8 gm. to just over 800 gm., or in terms of age, from about forty-three days to roughly ninety-nine days. During that period as a whole, the fibre measured 4·61μ on an average, the means for individual fœtuses ranging between 4·17 and 5·23μ. However, during subsequent stages of development until birth, a considerable increase in fibre diameter is evident, closely corresponding to the increase in body-weight.

For the purpose of clarifying the trend, linear regressions have been calculated separately for the two apparent segments of the curve. The regression lines fitted to the experimental results, as shown in Fig. 1, are based on the following equations:

$$\text{Segment 1}: \quad Y = 4{\cdot}319 + 0{\cdot}001065\,X$$
$$\text{Segment 2}: \quad Y = 3{\cdot}533 + 0{\cdot}001625\,X$$

where Y represents muscle-fibre diameter in μ, and X represents weight of fœtus in gm. Theoretically, therefore, the fibre increases in diameter by only 19·5 per cent from a fœtal weight of 8 gm. (4·328μ) to a weight of 800 gm. (5·171μ); but from a weight

Table 1. Percentage Frequency Distribution of Muscle Fibre Diameters of Different Weight Groups

Fibre diam. (μ)	Range of weights, within groups (in gm.) 12·6–25	26–50	51–100	101–200	201–400	401–800	801–1,600	1,601–3,200	3,201–6,400
n*	450	300	300	1,050	1,050	750	750	750	600
1·6	—	—	0·67	2·94	—	—	—	—	—
3·2	34·0	28·0	31·3	41·3	27·1	21·3	11·8	4·80	—
4·8	45·3	41·3	56·7	39·2	51·0	48·3	44·0	23·2	1·00
6·4	20·7	30·7	11·3	15·2	21·7	29·3	37·5	41·6	11·0
8·0	—	—	—	1·33	0·20	1·06	5·33	14·2	13·0
9·6	—	—	—	—	—	—	1·33	14·9	26·0
11·2	—	—	—	—	—	—	—	0·53	13·3
12·8	—	—	—	—	—	—	—	0·80	22·0
14·4	—	—	—	—	—	—	—	—	2·69
16·0	—	—	—	—	—	—	—	—	8·33
17·6	—	—	—	—	—	—	—	—	0·33
19·2	—	—	—	—	—	—	—	—	2·00
20·8	—	—	—	—	—	—	—	—	—
22·4	—	—	—	—	—	—	—	—	0·33
Group mean	4·56	4·70	4·40	4·39	4·66	4·90	5·45	6·71	10·80

* Number of observations per group

of 1,200 gm. to 5,000 gm. at full-term, the fibre increases by 113·2 per cent, from 5·483 to 11·658μ.

The range in muscle-fibre diameter at different stages of fœtal development is set out in Table 1, measurements on one fœtus, weighing less than 12·6 gm., having been omitted. Since the various weight-groups include unequal numbers of observations, the distributions are shown as percentages of their respective totals.

It is evident that the range is limited during the earliest stages; clearer definition of the exact range occurring was not achieved since measurements could be made to the nearest 1·6μ only. The first noticeable change is shown by the measurements for the group 51–100 gm., however, rather contrary to expectation. Here a proportion of smaller fibres, though only a fraction of the total, appear which reduces the group mean rather abruptly. The proportion of small fibres actually increases in the group weighing between 101 and 200 gm., following which stage they were no longer recorded. A substantial increase in the range occurs only in the groups of higher weight, particularly those of weights 801–1,600 gm. and 1,601–3,200 gm., much as would be anticipated in view of the results shown in Fig. 1. The widest range occurs at birth; but this group also includes the largest range in terms of absolute weight of the specimens.

The results obtained appear to support accepted theory on muscular growth prior to birth. While a differential growth-rate of the fibres, in terms of cross-diameter, is evident, further investigation[4] showed that the weight of the muscles sampled increased at a very nearly constant rate over the same period. However, despite the rather noticeable break in the curve illustrating age changes in cross-diameter of the fibres between, roughly, 800 and 1,200 gm., it is not inferred that cell formation ceases abruptly at approximately that stage. This aspect of the problem apparently remains to be settled, for while both MacCallum[5] and Cuajunco failed to observe evidence of recent division or incomplete separation of fibres beyond mid-fœtal life, Tello[6] identified new fibres in the full-term human fœtus.

The occurrence of a proportion of small fibres in fœtuses between the weights 51 gm. and 200 gm. agrees with Cuajunco's report on the subject. They were, however, rather less numerous than one would gather from the latter author's observations, and were last recorded in a 69-day-old specimen; Cuajunco reported small fibres up to the twenty-fourth week in the human fœtus.

The observations recorded in Table 1 indicate a range in muscle-fibre size from 4·8 to 22·4μ at birth. According to Tello[7], the largest of parent fibres remain larger and more fully developed than the daughter fibres throughout fœtal life, and can still be recognized by their size and distribution in early infancy. These latter fibres are described by Adams *et al.* as the 'B Fibres' of Wohlfart. The present results, however, provide but limited evidence on the presence of two types of fibres, so distinctly different in diameter that it should be shown by the shape of the distribution curve at birth. Though two modes are present, the first at 9·6μ and the second at 12·8μ, the difference is not as large as one would expect in view of the foregoing description of the fibre types. Indeed, the shape of the distribution curve obtained is obviously influenced by the fact that newly-born lambs are included ranging in weight from 3,591 to 5,248 gm.

Detailed results of the investigation will be published elsewhere.

Acknowledgments are due to Messrs. I. Gordon, R. W. L. Averill and Dr. G. L. Hunter, School of Agriculture, and to Mr. G. Pluck, Animal Research Station, Cambridge, for their valuable assistance with the collection of material. To Dr. John Hammond I am grateful for providing facilities and for his advice and encouragement. [March 18

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TIDAL GRAVITY MEASUREMENTS IN THE SHETLANDS

EFFECT OF THE TOTAL ECLIPSE OF JUNE 30, 1954

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THE application of tidal gravity measurements to geophysical and geological problems has been discussed in a previous communication[1]. The first results of an extended investigation into the tidal variation at Unst (Shetlands), including measurements in the zone of totality during the eclipse of

June 30, 1954, will be described here. Observations at these high latitudes are of special interest for two main reasons. First, they extend our knowledge of the dynamic elastic deformation of the earth's sphere into a region not yet properly investigated. Secondly, in this region the variations of the vertical component of gravity are predominantly diurnal and offer, due to the small range of daily temperature variations and the length of the observation period, an additional opportunity of determining the diurnal elastic deformation which, in contradistinction to the semi-diurnal variations, may be influenced by the liquid core of the earth[2]. Another point of interest is that new information on the oscillations of tectonic blocs can be expected, as the Shetlands belong to the same general tectonic structure as the northern part of the British Isles, and meteorological events in the Atlantic should influence the Shetlands in a similar way. Furthermore, the unique opportunity of observing in the zone of totality of an eclipse makes it possible to obtain more exact experimental information on the problem of a possible variation of gravitation by interposing a third body between two attracting masses[3].

Three gravimeters were used simultaneously: two Frost gravimeters (No. 32 and No. 54) the properties of which have been described previously[4], equipped respectively with one and two thermostats, and a normal Worden gravimeter (No. 189) in an additional thermo-insulating container. The Frost gravimeters were at Baltasound (lat. 60° 45′ 45″ N.; long. 0° 51′ 10″ W.) and the Worden instrument at Skaw (lat. 60° 49′ 08″ N.; long. 0° 47′ 30″ W.). The Frost gravimeters were normally read half-hourly by ocular observation, and a continuous set of observations for both gravimeters during June 12–July 15, 1954, was obtained. The readings of the Worden instrument were registered photographically. Due to difficulties with the camera, uninterrupted half-hourly records were only obtained during June 29–July 15. During June 29–July 1, the readings of the Frost gravimeters were practically continuous shortly before, after and during the hours corresponding to the eclipse, and the frequency of photographic exposures was increased to 5- and even 2-minute intervals for the Worden meter.

The most reliable results were obtained with Frost 54, as the good fit with the theoretical tidal curves showed at once, and as was expected from previous experience with it. The other Frost meter, No. 32, shows a strong influence of pressure and a phase lag against the pressure variations. The pressure correction is therefore particularly difficult for this instrument, because of the large amplitude and high frequency of the barometric variations in this region of high latitude. The Worden gravimeter, which in these experiments was used for the first time for continuous tidal measurements, shows a strong elastic drift and is also affected by outer temperature variations the influence of which can be assessed exactly only with difficulty. Its damping is also less effective, so that it is influenced to a certain degree by microseisms. The results obtained with Frost 32 and Worden 189 have therefore a greater margin of mean deviation.

The results of the harmonic analysis are shown in Table 1 for Frost 54, using the Admiralty method.

From these results the mean value of G_c for semi-diurnal tides is 1·20; for diurnal tides 1·09. The overall geocentric mean, weighted according to the respective amplitudes, is $G_c = 1·13$. The accuracy of the value is mainly determined by the accuracy of the calibration factor and by the influence of systematic pressure variations. According to former experience, it may be assumed to be ± 3 per cent in the present investigations.

The factor G for semidiurnal tides is in good general agreement with that found in lower latitudes, but lies on the high side, if compared with 1·10 ± 0·04 for the semidiurnal tides M_2 and S_2 at Peebles (Scotland), which were measured with the same instrument. The phase shift of 15° for M_2 in the Shetlands is rather large and indicates the influence of oceanic tides. A definite answer regarding the significance of the difference can therefore be given only after discussion of these maritime influences.

The diurnal elastic yielding is definitely lower than the semidiurnal. Their ratio is not influenced by uncertainty due to the calibration factor, which is about ± 0·7 per cent. As at Unst, the amplitude of the diurnal tides is more than double that of the semidiurnal tides, and the observational period is one month; this difference seems to be significant and should contribute towards obtaining quantitative data for assessing the influence of the liquid core. A discussion of the problems raised by the harmonic analysis data will be given in a comprehensive paper elsewhere.

The general drift of Frost 54 determined according to the Admiralty method shows no correlation with the barometric curve, proving the correctness of the pressure correction, but shows a correlation with the general pressure changes over the North Atlantic. This indicates movements of the tectonic bloc induced by these changes similar to those already observed in the British Isles[6].

A unique opportunity was given by the total eclipse of the sun on June 30 of studying the influence

Table 1

Component	M_2 H	M_2 $\varkappa$	S_2 H	S_2 $\varkappa$	K_1 H	K_1 $\varkappa$	O_1 H	O_1 $\varkappa$
H Theoretical	17·80	—	8·29	—	37·15	—	26·50	—
Set I	21·71	+ 14·2°	10·06	− 4·8°	41·00	− 5·4°	28·22	+ 3·6°
II	21·55	+ 14·9°	10·02	− 4·6°	41·46	− 5·8°	28·57	+ 2·6°
Vectorial mean	21·64	+ 14·6°	10·04	− 4·7°	41·54	− 5·6°	28·40	+ 3·1°
$G = H_{obs.}/H_{th.}$	1·22		1·21		1·12		1·07	
G_c	1·20		1·20		1·11		1·06	

M_2 (T = 12·42 h.) main lunar and S_2 (T = 12·00 h.) main solar semidiurnal constituents.

K_1 (T = 23·93 h.) lunisolar and O_1 (T = 25·82 h.) main lunar diurnal constituents.

The amplitude of vertical component of gravity H is in thousandth of milligals. $\varkappa$ = phase difference against theoretical phase; G = gravimetric factor for geographical latitude; G_c = gravimetric factor for geocentric latitude = $H_{obs.}/H_{theor.}$

Set I comprises the values for integral hours, Set II those for the half-hours.

on gravity due to the interposition of the moon between the sun and the earth[7]. Although the centre of totality ran nearly forty miles to the north, the observational points were well in the zone of totality, and the duration of totality was about 86 sec.

In order to investigate the effect, it was necessary to compare the measurements of gravity during the time of the eclipse with the statistical oscillations of the measurements on adjacent normal days.

The method of reducing the observations of Frost 54 is as follows. After correction for pressure, the general drift was removed using the Admiralty method. As the elastic yielding of the earth is known from the harmonic analysis (Table 1), the tidal effect has been subtracted from the corrected observations of June 29 and 30 and July 1. It showed that, within the relevant time interval of 10h. 30m.–14h. G.M.T., the curves of the residuals on all three days were very nearly linear. In order not to introduce any bias, therefore, a linear drift correction was applied to the residuals. The result is shown in Fig. 1. It shows the statistical oscillations (including slight systematic deviations from linearity) of the residuals of normal days in the bottom and top graph, compared with those during the eclipse. All three graphs are well within the limits of ± 10 thousandths of a milligal. The standard deviation of the residuals on eclipse day is 2·7 thousandths of a milligal.

The results from the two other gravimeters were treated in a similar way, but the direct observed values without pressure correction have been used. Furthermore, the curves for the eclipse day had to be smoothed by double averaging for both gravimeters to make them comparable with the adjacent days, as Frost 32 was oscillating due to strong microbarometric variations, and Worden 189 due to the microseisms of the island on eclipse day. The

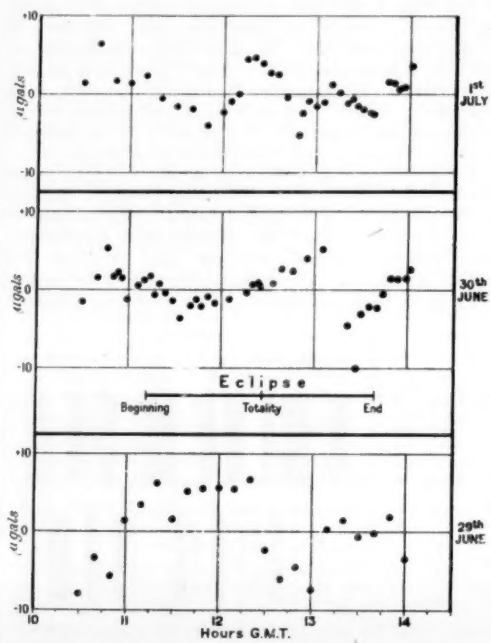

Fig. 1. Gravitational residuals of gravimeter Frost 54. Deviations from mean gravity corrected for tide elasticity and drift

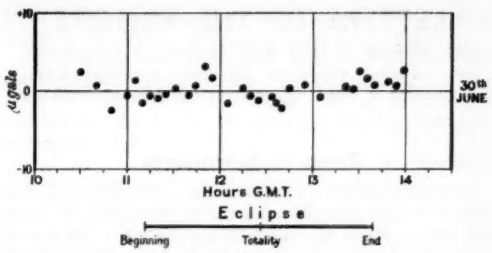

Fig. 2. Mean of gravitational residuals of all three gravimeters on eclipse day

standard deviations on eclipse day were 3·6 and 3·7 thousandths of a milligal respectively.

Fig. 2 shows the mean for all simultaneous observations of the three instruments during the eclipse, giving each gravimeter set the same weight. As the times of reading sometimes differed slightly, the range for coincidence for averaging was taken as 3 min. at the most. The standard deviation of these means is 1·4 thousandths of a milligal.

The statistical discussion of the combined observations, which will be given in a comprehensive paper elsewhere, leads to the following conclusions:

(1) No significant systematic effect was observable during the eclipse.

(2) The consequence of an absorption or attenuation of the gravitational field of the sun would be an apparent increase of gravity for the observer. The chances of detecting a systematic effect of this kind would have been more than 100 : 1 for an effect showing a maximum of 3 thousandths of a milligal at totality. This means that a systematic absorption effect equivalent at its maximum to three parts in one thousand millionths of the earth's gravitational field would have been certainly observed. The vertical component of the sun's gravitational field is calculated to have been 470 milligals, so that the interposition of the moon between the earth and the sun could certainly not have altered the intensity of the field due to the sun by more than one part in a hundred thousand.

(3) Regarding the possibility of an absorption effect of matter on gravity, 3 thousandths of a milligal correspond, applying Majorana's[8] theory, to an upper limit for an absorption coefficient of gravity α of less than 10^{-14}, that is, about a thousand times less than the value deduced by Majorana from his experiments.

I wish to thank all who helped in this investigation, especially the members of the expedition, H. T. Rochelle, A. N. J. Hales, C. E. Saul and R. Brown, and Mr. and Miss Saxby, of Halligarth, for their hospitality on Unst. Acknowledgment is also made to the Chairman of the British Petroleum Co., Ltd., with whose permission this communication is published.

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LETTERS TO THE EDITORS

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Sleep in Ruminants

During digestion experiments with cattle, it was observed that the animals never appeared to sleep and always used the same lying position. In recent years the behaviour of cattle and sheep has been carefully studied by numerous workers, particularly under grazing conditions; the subject has been reviewed by Tribe[1] and Hancock[2]. In spite of this attention, the almost complete absence of reference to sleep is a striking feature of the reports. Brownlee[3] could find no evidence that healthy cattle ever lost consciousness either by day or night. Similarly, Hancock[4] found that it was debatable if cows ever sleep; even at times of total rest they kept their eyes open except for very short periods—a few minutes at most—when they generally rested their heads on the flanks.

It is difficult to find an exact definition of sleep acceptable by all authorities; in the present work a search has been made for the marked relaxation and loss of consciousness (especially of vision) which are the more obvious manifestations of sleep in other animals. In the vast majority of cattle seen at night, the eyes were open and clearly watching the observer. In the few instances where they were closed the movement of an ear would often betray consciousness, or slight noises such as rubbing together of the fingers would evoke an immediate reaction.

In order to confirm that the absence of mention of sleep from published reports did in fact mean that none was observed, I have communicated with a number of the observers. Their replies were in close agreement with observations here, namely, that sheep and cattle sleep little if at all, rarely closing their eyes and seeming even then not to lose consciousness. When lying, they keep the thorax upright and only very rarely and for short periods lie out flat. Observation and inquiry in zoos has confirmed that the apparent lack of sleep and the typical lying position are general characteristics of ruminants.

Following the classical studies of Schalk and Amadon[5] on the mechanical process of the reticulo-rumen, it has become increasingly clear that the arrangement of the large amount of digesta in the reticulo-rumen is partly dependent on gravity. Tilting the organ either laterally or in a dorso-ventral plane must lead to displacement of the fluid materials found in the reticulum and ventral rumen and of the gas bubble normally present in the dorsal sac of the rumen. This leads to dysfunction of the reticulo-rumen[6]. The twist and curve given to the body by the sideways position of the pelvic girdle in lying ruminants other than camels will not interfere with the arrangement in the anterior (cranial) rumen and reticulum. The role of gravity in the proper functioning of the reticulo-rumen is clearly the reason for the upright position of the thorax during lying. Young calves appear to sleep and sometimes lie flat on their sides (private communication from J. H. B. Roy and K. W. G. Shillam), and very fat beef cattle sometimes roll over, because of their inability to maintain the normal lying position, and may also sleep. It appears, therefore, that the apparent absence of sleep and the specialized lying position are, as would be expected, found only in normal adult ruminants in which the reticulo-rumen is fully functional. Steinhart[7] has shown that sleep is normal in the horse, an animal which in the wild state has the same environment as several species of ruminants. Stabled horses in Germany slept on average seven hours out of the twenty-four, and Steinhart was able to gauge the depth of sleep by the time required for reaction to the stimulus of offered food. The lightest form of sleep (reaction in less than 2 sec.) was sometimes observed in standing horses; but deep sleep was only observed in horses lying out flat. In these latter instances the reaction time exceeded 6 sec. and there was usually no reaction. In extensive nocturnal observation of ruminants, I have yet to find an individual which would not have reacted to the presence of the observer before Steinhart's test could have been applied.

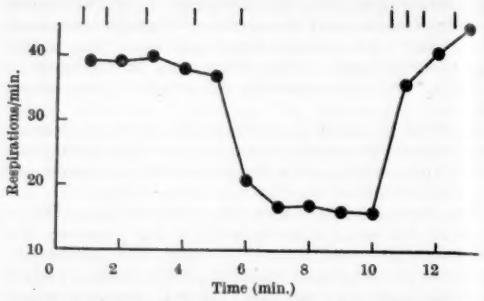

Fig. 1. Fall in respiration-rate in one of the periods of slow breathing. This occurred at 0320 hr., while the cow was lying resting. The short vertical strokes indicate contractions of the reticulum

A modified kymograph giving an ink tracing on paper charts has been used for recording pressure changes in the reticulum of fistulated cows during periods of many days duration. The records show respiration-rate, reticulo-ruminal motility and whether the animal is standing or lying and ruminating or resting. They have been supplemented by frequent observa-

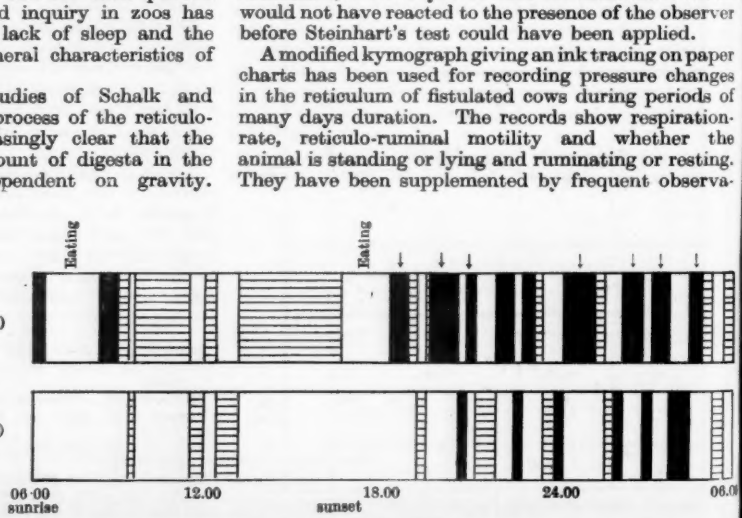

Fig. 2. Periods of (*a*) eating and resting and (*b*) ruminating, while standing (shaded areas) and resting (black areas). Typical values for a cow kept in a cowshed. In the periods of lying resting indicated by arrows, there were ten periods of slow breathing totalling 31 min.

tion at night. During the night there is little general slowing of either reticulo-ruminal activity or respiration-rate while the animal is lying resting, lying ruminating or standing ruminating.

Deep regular breathing at a slow rate is frequently, but not invariably, found in sleeping animals. The kymograph records were accordingly searched for such breathing and a small number of periods were found. These could be detected in spite of the dependence of normal respiration-rate on temperature; on days when the temperature averaged about 50° F. the mean respiration-rate was 19–25/min., whereas at 65° F. it was 45–49/min. in the same two cows. The periods of slow breathing (Fig. 1) were most easily observed at the higher temperatures. Their duration varied from 1 to 10 min., with an average length of less than five minutes, and they frequently ended suddenly. This slow deep breathing was seen only while the cows were lying at night and resting, and the longest total observed in any one night was 36 min. During these periods there was usually a marked slowing of the rate of contraction of the reticulum (Fig. 1). Subsequent recording at the lower temperature disclosed a few periods of slow breathing, also while the animal was lying resting. Because of the slower general rate of respiration, these were less distinct than the periods observed earlier, but were again accompanied by a lowered rate of contraction of the reticulum. Observation of the cows during several periods of slow deep breathing disclosed no loss of consciousness; the periods do, however, appear to represent the maximum relaxation achieved by cattle and the closest approximation to sleep, and it is probably then that the eyes are sometimes closed. The periods were found only when the animal was lying resting and never during rumination.

Rumination occupies a series of periods, usually of less than an hour in length, throughout the twenty-four hours (Fig. 2). The amount of time spent ruminating varies with such factors as the fibrous properties of the diet and the availability of grazing; it frequently totals nine hours out of the twenty-four and, especially in grazing animals, is somewhat concentrated into the hours of darkness. There seems to be no possibility that sleep occurs during rumination, because, in addition to the disturbing effect of the constant chewing and regurgitation, the maintenance of the head in the unsupported position invariably found during rumination would appear to demand a considerable degree of consciousness, to preclude the "immobility of the body" and to demand the function of that "sum total of tonic reflexes of proprioceptive, labyrinthine and visual origin that are responsible for righting the body and maintaining the normal position" and which is usually inoperative during sleep[8]. This may even be necessary, to a lesser extent, for the maintenance of the characteristic lying position of ruminants, especially when the head is not resting on the legs or on the ground.

Since during the night the periods of lying resting are interspersed with periods of standing and of rumination (Fig. 2), it follows that if sleep occurs at all in cattle it must be of the polyphasic type.

It is concluded, therefore, that under normal conditions of management healthy adult cattle and sheep, and probably ruminants in general, sleep little, if at all. If sleep does occur, it can only be of a very light and transient nature. This peculiarity of ruminants may be related to the need for maintaining the thorax in an upright position for proper functioning of the reticulo-rumen, and to the requirement of time and consciousness for rumination. The implications of this observation are being investigated.

My thanks are due to all those who have communicated privately with me or this matter. I wish also to thank members of the staff of the London and Bronx Zoos, who kindly answered my inquiries and aided my visits.

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Responses of Some Marine Plankton Animals to Changes in Hydrostatic Pressure

It has generally been thought that aquatic animals, which lack gas-filled spaces in their bodies, would not perceive variations in hydrostatic pressure due to small changes in depth, since their bodies are permeated with fluid of very slight compressibility[1]. Only animals possessing gas-filled spaces, such as fishes, with their swim bladders[2], and certain aquatic insects, with special pressure gauges connected to the tracheal system[3], had been shown to respond to pressure changes, until recently. Then the discovery that decapod larvæ swim upwards, in response to pressure increases[4], suggested that tests for pressure sensitivity should be carried out on animals not known to possess gas organs.

The animals listed in Table 1 proved to be clearly sensitive. When the pressure was increased, they generally became more active and swam upwards; when it was decreased, they became less active, or completely inactive, and allowed themselves to sink. This behaviour can be termed high 'barokinesis', usually combined with negative geotaxis. The only animals observed to give an active response to a decrease in pressure (low barokinesis, combined with positive geotaxis) were the fishes and the ctenophores. Their behaviour was doubtless correlated with the fact that these animals alone were buoyant, for *Blennius* larvæ have a swim bladder[5], and healthy *Pleurobrachia* reduce their specific gravity in some other way, possibly eliminating heavy ions, as in *Halicystis*[6]. The final column of Table 1 shows the minimum change in pressure which produced a significant response in a proportion of individuals of each species. A millibar is equivalent to 1 cm. of sea water. Bracketing of a figure indicates that no smaller changes were given to the species concerned, which may therefore be much more sensitive than the bracketed figure suggests. Evidently the degree of sensitivity shown is sufficient to help these animals to control their depth.

Other workers have proved that control of depth, in copepods and cladocerans, is largely due to positive phototaxis at reduced illumination[1]. The relative importance of the light response and the pressure response was investigated by confining similar batches of animals in two vertical glass tubes, which were raised and lowered together in the sea. One was

Table 1

Class or Order	Species	Minimum change (in mb.) producing a significant response
Teleostei	Larvæ of *Blennius pholis*	5
Decapoda	Megalopa larvæ of *Carcinides maenas*	10
	Corresponding stage of *Galathea* sp.	10
Isopoda	*Eurydice pulchra* (pelagic during high water only)	50
Copepoda	*Caligus rapax*	(800)
Polychaeta	Larvæ of *Poecilochaetus serpens*	(800)
	Pelagic adults of *Autolytus aurantiacus*	(800)
Ctenophora	*Pleurobrachia pileus*	50
Hydromedusae	*Phialidium hemisphericum*	(800)
	Gossea corymetes	(800)
	Eutima gracilis	(800)

open to pressure changes and the other was sealed at atmospheric pressure. The vertical distribution of the animals inside each tube was recorded with the help of an 'aqualung'. So far, we have used this apparatus only with batches of *Eurydice*, which usually remained near the bottom of the tubes. They swam up only in the tube which was open to the increased pressure at greater depths (2–10 m.). The considerable reduction in light intensity, which at 10 m. was about 1 per cent of the illumination near the surface (vertical extinction coefficient 0·45), appeared to have no effect upon them.

We failed to obtain any clear responses to pressure changes in *Calanus*, *Tomopteris*, *Sagitta*, *Alloteuthis* larvæ and various small plankton animals.

There are special reasons for the pressure response being particularly useful, as a depth-regulating mechanism, to the animals listed in Table 1. The majority of these are large polychætes and Crustacea of high specific gravity, which have to spend much of their time swimming fairly hard in order to maintain their depth. They sink rapidly during their periodic rests, so they must control the duration of each resting period, if they are to remain suspended. *Calanus*, *Tomopteris* and *Sagitta* do not sink rapidly while resting. Planktonic cœlenterates are of specific gravity rather similar to that of sea water; but, if they lacked pressure responses, they would be liable to change level quite widely while resting, because they spend most of their time inactive, with their extended tentacles slowly trailing through the water. This is, of course, the way in which the majority catch their prey.

Fish have to guard against their unstable buoyancy mechanism moving them upwards or downwards, so they might be expected to be particularly sensitive to pressure changes. Nevertheless, the minimum changes to which *Blennius* larvæ responded were not much smaller than those which induced responses in decapod larvæ, and the delay between stimulus and response was generally greater in *Blennius* than in *Carcinides* and *Eurydice*. It is therefore doubtful whether possession of a swim bladder confers a particularly high degree of sensitivity to small pressure changes. No gas organs are known in any of the other animals dealt with here, and it is very unlikely that medusæ or ctenophores possess even the smallest of gas vesicles, for these would easily be visible under the microscope in such transparent animals. Some other mechanism of pressure perception must be sought. So far the only effects of hydrostatic pressure which have been observed in living tissues have been effects due to very high pressures[7]; but these were profound and eventually lethal. Evidently the very existence of life at the greatest ocean depths depends on special physiological adaptation to high pressure[8]. Considering this, it is less surprising to find evidence that changes of less than a decibar may produce effects on living tissues which are sufficiently important to be appreciated by the animals concerned; but the mechanism of perception is quite uncertain.

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Astaxanthin in the American Flamingo

The flamingo, *Phoenicopterus ruber*, derives from its dietary carotenoids the conspicuous rich pink to red colours of its feathers, tarsal and pedal skin and lower bill-mandible. Captive flamingos gradually lose their rich pigmentation unless appropriate dietary measures are taken. The presumptive role of crustacean carotenoids in supplying pigmentation to the birds in Nature is given some support by observations in zoos[1] and by Manunta's[2] reported recovery of an astacene-like carotenoid from the fat of a flamingo.

In the San Diego Zoo, a flock of two dozen flamingos has received, since March 1954, finely ground carapace (plus some hypoderm) of the California 'spiny lobster', *Panulirus interruptus*, added as a regular supplement to the usual diet of beef- or horse-liver, grass-pellets, millet, wheat, rice, dried flies and ground shrimp. As a result, the American species, *Phoenicopterus ruber*, soon developed striking pink and vermilion colours in the skin (not in the transparent scales) of the tarsals, heel and webbed toes, the lower mandible and the new plumes. Three members of a smaller species, the Chilean flamingo (*P. chilensis*), exhibit bright pink skin over their heels and webbed feet, but not elsewhere; their feathers remain mostly white as in Nature, but now with a few pink ones. The rest of the general body-skin is of normal, pale appearance (like that of domestic fowls) in both species.

Although the birds receive mixed carotenoids in their diet (notably since they pluck grass as well), the various tissues yield chiefly hypophasic carotenoids, and the majority of these seem to be partially oxidized xanthophylls, their chromatographic fractions giving atypical spectral absorption curves. The minor amounts of epiphasic carotenoids include no typical carotenes, but apparently oxidation products of carotenes.

No traces of astaxanthin, or of any acidogenic carotenoid, were detected among the carotenoids of the yellow-orange sub-dermal or visceral fat, the orange adrenals, the liver, pancreas, spleen, lung, muscle, immature ovary or testes of recently expired birds which had received the regular diet. Nor did the carotenoid-rich plasma of blood yield astaxanthin.

The erythrocytes contained no carotenoids. Even the blood-laden shafts of pin feathers, while rich in carotenoids, yielded no trace of the acidogenic carotenoid save for a possible trace in one sample. No carotenoids were recovered from the pale, semi-fluid contents of small or large intestine.

However, the bright pink feather barbs themselves, as well as the brilliant vermilion skin underlying the tarsal scales, yielded copious amounts of astaxanthin as a prominent fraction of the carotenoid complement. The identity of the astaxanthin was established both by the single broad maximum of its oxidized derivative, astacene, at 495–496 mμ in pyridine, matching that of astacene from *Panulirus* and other crustaceans (Beckman *DU* photoelectric spectrophotometer), and by mixed chromatography of the astacene derivative from skin, from feathers and from *Panulirus*. Each chromatogram alone, and the mixture of the three, appeared to be identical on columns of magnesium oxide and 'Celite'.

Hydrolysed feathers yielded no epiphasic carotenoids, but only astacene and neutral hypophasic derivatives. The skin provided three or more neutral xanthophylls of unfamiliar spectra, two minor atypical, persistently epiphasic fractions, and considerable amounts of astaxanthin.

A roseate spoonbill (*Ajaia ajaja*), receiving the same diet as the flamingoes, grew pink feathers which, after alkaline hydrolysis, yielded astacene as the predominant, if not the only, carotenoid.

The metabolic fractionation of dietary carotenoids by the American flamingo seems to involve oxidative processes as well as partial transfer of unchanged astaxanthin to the integument. A remaining puzzle involves questions as to (1) the enzymic astaxanthin-oxidizing agency, if any, residing in the gut or in the blood, which must, nevertheless, undoubtedly transport astaxanthin to the tarsal skin and plume follicles, and (2) the rate of destruction of astaxanthin en route. Experimentation continues as opportunity permits, and a full report will be published elsewhere.

I thank the following for their interest, co-operation and technical aid: at the Scripps Institution, Dr. Arthur L. Kelly, Mr. E. F. Corcoran and Mr. Elmer Squier, research assistants; at the San Diego Zoo, Dr. Charles R. Schroeder, director; Mr. K. C. Lint, curator of birds; Mr. Merl Moody, manager of the food warehouse; and my late son, Stephen, university student and summer-time assistant keeper in the bird-yard, who was accidentally killed on July 15, 1954.

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Recognition of Appropriate Backgrounds by the Pale and Black Phases of Lepidoptera

The Lepidoptera, with their frequent examples of highly specialized cryptic coloration, have been used extensively for experiments on the various aspects of evolution. More marked evolutionary adjustments have in fact been witnessed in these than in any other natural order. Thus J. B. S. Haldane[1] showed that in the Manchester district between the years 1848 and 1898, the jet-black form of the peppered moth (*Biston betularia f. carbonaria*) had an approximate 30 per cent advantage over pale lichen-like individuals, which were the only ones known there until the middle of the last century. Nor is this occurrence unique among the Lepidoptera of Britain. About fifty other species are, at the present time, in the process of changing their populations from light individuals to black in large areas of England.

Pollution in the air is carried great distances from industrial centres, and with the prevailing westerly wind there is a much greater contamination of foliage than has been realized. This has been demonstrated by a study of leaf washings from various parts of England (Kettlewell, unpublished work); and it appears that over the whole of eastern and south-eastern England as well as the industrial midlands there is a constant precipitation of pollution sufficient to cover vegetation and to eliminate most of the lichens and algae on tree trunks and boughs, which are now largely bare and black. E. W. Jones[2] has shown "that the amount of pollution by smoke is a factor that overrides all others in determining the amount of lichens present" and also the number of lichen species. Hence in many districts the number of appropriate resting sites for light-coloured insects to select in order to pass the day in relative security is being progressively restricted.

Thus it is of the greatest importance to know whether a cryptic insect, on taking up its resting position at dawn, chooses a site suitable to its colouring. Accordingly, an experiment was designed to test this possibility in its simplest form. Alternate black and white backgrounds were presented for choice. A large cider barrel was lined with alternative broad strips of black and white paper of similar consistency, so that each had the same surface area. This was covered with muslin and placed in such a position out of doors that the light fell evenly from above. Each evening three black (= *f. carbonaria*) and three pale *Biston betularia* (= *f. typical*) were released into it, and early the following morning the position of each insect was recorded. Any moth overlapping two different coloured strips by any part of its anatomy whatsoever was excluded from the scoring, as were those resting on the bottom or on the top.

A total of 198 *betularia* were released, 99 of each phenotype. Of these, 80 were disqualified for overlapping, and it is of interest that exactly half of these were of each form, so that one did not tend by habit to sit on the edges more than the other. Table 1 shows the findings for the 118 scored.

From this it can be seen that 77 *betularia* chose correct positions (38 *carbonaria* and 39 *typical*) and 41 incorrect. The 2 × 2 table gives a $\chi^2_{(1)} = 10{\cdot}9$, for which P is approximately 0·001.

It is not suggested as probable that each phenotype actively searches areas of woodland for a correct background; but that having come to rest on a tree in its breeding area, it shifts its position so as to make the best of the local advantages offered. It

Table 1. Background Recognition in *Biston betularia*

	Black (= *carbonaria*)	White (= *typical*)	Total
Black background	38	20	58
White background	21	39	60
Total	59	59	118

would appear, therefore, that the black and pale forms appreciate their immediate backgrounds. It is possible that they gauge the contrast differences between the colour of the scales surrounding the eyes and that received by that segment of the eye which registers the light reflected from the tree trunk. To test this, I have attempted to transplant the tufts surrounding the eye of the *carbonaria* on to the pale *typical* and vice versa, but a satisfactory technique is so far lacking.

This is the first experimental demonstration of the fact that distinct phenotypes of a moth tend to rest upon backgrounds appropriate to their colouring, a matter of much consequence in studying the micro-evolution of the Lepidoptera. Moreover, it could produce a balanced polymorphism in certain parts of a country, if the degree of pollution became constant. It must also be one of the factors which accounts for the high rate at which industrial melanism has spread in manufacturing areas.

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Genotype–Environment Interactions in *Lolium perenne*

Until recently, the importance of genotype–environment interactions, though generally recognized by plant and animal breeders, has been largely neglected in most quantitative studies. Despite their possible removal by scaling[1], theoretical objections to this procedure have been made and these objections are underlined by recent results in, for example, *Drosophila*, tomato[2] and ryegrass[3].

I have been occupied in estimating the genetic components of variation in herbage weight in *Lolium*, as determined mainly by tiller number and tiller weight, using spaced plants in the field under periodic defoliation. Significant interactions between frequency of cutting and fertility-levels on one hand, and genotype on the other, were observed early in the experiment. Significant interactions also occurred in a selection experiment between genotype and date of cutting in that the effect of recurrent selection for *high* and *low* production (green weight) in the field between spring and autumn vanished at assessments made from late autumn to winter.

For an analysis of the factors responsible, three or four representative individuals of these progenies, selected for high and low green weight, were cloned. The progenies covered a range of outcrosses and slightly inbred material. These selection groups were grown in glasshouses during the winter of 1954 under high and low temperature combined with high and low light (high temperature, approximate average: 70° F. day, 50° F. night; low temperature: 60° F., 40° F.; high light: natural light extended artificially to 16 hr. by light of 600 W. from mercury vapour and incandescent lamps; low light: natural day-length, whitewashed glasshouse). Both temperature and light fluctuated with outside conditions. All plants were harvested three times at one-monthly intervals until, after the third cut, the first signs of reproductive development were observed under certain treatments.

Preliminary results show conspicuous interactions between selection group and temperature in different characters at all harvests, especially under 'high' light conditions. A typical example from the outcrossed group is given below for material which had been selected in two cycles for *high* and *low* weight.

Table 1. Green Weight (Tiller No. × Tiller Weight) for Outcrossed Group (Third Harvest)
Means and stand. errors for three plants each of two clonal propagules

Selected for	Warm house	Cold house
High weight	9·3 ± 1·2 (37 × 0·26)	6·5 ± 1·2 (38 × 0·18)
Low weight	5·8 ± 1·2 (27 × 0·21)	8·8 ± 1·2 (41 × 0·22)

It is apparent that yield was raised in the high-weight selection group through high temperature increasing tiller weight, and in the low-weight group through low temperature increasing tiller number.

Similar results were obtained in more homozygous material; for example, in derivatives obtained from one 'high' plant by selecting for high weight in two generations of inbreeding (selfing and sib-crossing).

Table 2. Green Weight (Tiller No. × Tiller Weight) for Inbred Group (Third Harvest)
Means and stand. errors for two clonal propagules of 'high' plants

Plant No.	Warm house	Cold house
Ba 1904/18	6·6 ± 0·8 (30 × 0·23)	4·6 ± 0·8 (46 × 0·10)
Ba 1904/5	2·4 ± 0·8 (19 × 0·13)	5·8 ± 0·8 (48 × 0·12)

It is possible that such reactions to temperature are of importance in maintaining diversity in populations of perennial ryegrass in the field.

Similar interactions of genotype with light treatment were much less apparent. This is thought to be mainly due to the observed tendency—supported by the physiological trials of Mitchell[4]—that, under certain conditions, while light intensity increases tiller number and average tiller weight, high temperature decreases tiller number and increases tiller weight.

Similar responses in plant yield, tiller weight and tiller number to temperature and light intensity were found between *L. perenne* and the higher winter-producing *L. multiflorum* and in short-rotation ryegrass, a synthetic strain derived from crosses between them.

The existence of 'climatic races' has been demonstrated before[5], and their occurrence within a single population has been shown recently by similar methods in *Achillea*[6], in mutation work in other species[7], and in other aspects of ecotypic differentiation in *Lolium*[8].

Whatever the origin of these differences may be, such examples stress the necessity of providing for the separation of terms for certain genotype–environment interactions of possible importance in quantitative inheritance studies. In default of these, the statistics and heritabilities estimated are relative only. The estimation of genotype–environment interactions can be very difficult in field trials, where temperatures fluctuate at different levels, unless major temperatures or light-levels can be represented by different locations. It is suggested that temperature-levels were partly responsible for the significant interactions found by Corkill (unpublished work) in

the productivity of clonal material of a wide range of ryegrass plants at three New Zealand stations at different latitudes.

Practically, these difficulties mean that, after the elimination of adaptive failures and deleterious mutations, there are serious obstacles in the way of further improvement in the average performance of pasture strains by a more precise selection towards a certain ideal type of individual with characters representing the highest yield components. Irregular changes from one temperature-level to another—similar to those discussed here—occur under New Zealand conditions within very short periods of the same season and, of course, between different years. These changes would favour different growth types so that calculation of a reliable selection index would be very complicated indeed, and would involve allowance for seasonal differences.

In the breeding of improved strains of pasture plants selection is usually carried out on spaced plants; but the strains are ultimately used under sward conditions. There are indications from this series of experiments that interactions between spacing and genotype are such that selection methods would be more successful if the effect of spacing on performance were taken into consideration.

Detailed results of the studies reported here will be presented elsewhere. I thank Mr. A. C. Glenday for constant help in statistical interpretations, and Mr. L. Corkill, chief plant breeder, and other colleagues for helpful suggestions and discussions.

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Zinc in the Metabolism of *Fusarium vasinfectum* Atk.

That zinc is essential for the growth of *Fusarium vasinfectum* has been established by one of us (L. S. D.)[1]. That the fungus produces certain phytotoxins *in vitro* and that one of them, namely, fusaric acid, possesses antibacterial properties also, has been reported earlier[2]. The present investigation has revealed a further relationship between zinc concentrations in a purified medium and antibiotic production.

F. vasinfectum was grown in a sucrose–nitrate basal medium (KNO_3, 5·0 gm.; KH_2PO_4, 2·5 gm.; $MgSO_4.7H_2O$, 1·25 gm.; sucrose, 25·0 gm.; water, 1 litre) purified and amended with constant and sufficient amounts of iron, copper, manganese and molybdenum, with concentrations of zinc alone varying from 0 to 100 μgm. per flask. The amendments were added individually to 25-ml. aliquots of medium (adjusted to *p*H 3·0) in 500 ml. 'Hysil' conical flasks, covered, as usual, with inverted beakers[3]. After 15 days growth of the organism (28° C.) the antibiotic/toxic potency (expressed as fusaric acid equivalent) of culture filtrates was determined by the bio-assay method of fusarial toxin[4], and the mycelial growths were washed, dried and weighed (Fig. 1).

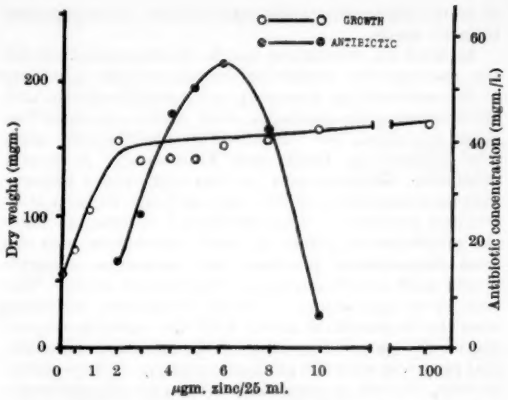

Fig. 1. Effect of zinc on the growth and antibiotic potency of *Fusarium vasinfectum* Atk.

Fig. 1 shows the indispensability of zinc for normal growth (as indicated by dry weight) and antibiotic production; antibiotic production, however, was not detectable until the addition of 2 μgm. zinc, and peak antibiotic potency was at a much higher level of zinc than that at which the organism attained normal growth. Higher concentrations of zinc markedly reduced antibiotic production, which was completely inhibited at the 100-μgm. zinc level. Similar results have been reported for *Streptomyces griseus*[5]; but in the present case, antibiotic production appears to be inhibited at much lower levels of zinc than in *S. griseus*.

Further investigations with higher initial levels of *p*H (adjusted before autoclaving) and different periods of incubation are under way.

We are indebted to Prof. T. S. Sadasivan for valuable help.

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Nicotine Degradation *in vitro* induced by Agents from Tobacco Seed

It has been recorded in the literature that nicotine, if brought in contact with tobacco seeds, undergoes a gradual decomposition[1,2]. The nature of the chemical reactions involved, and of the agents that initiate these reactions, have remained obscure. The following preliminary results during detailed investigations of this effect in our laboratory have been obtained.

In the course of thirty to fifty hours at room temperature, nicotine in aqueous solutions of 10^{-3} to 10^{-2} molarity, neutralized with sulphuric acid to *p*H 7, is converted, in the presence of sterilized air, into a series of degradation products on addition of a small volume (5–10 per cent of the volume of the main solution) of water that had previously been passed

at room temperature through a layer of non-ground tobacco seeds.

At least six substances can be distinguished among the successively appearing transformation products of the alkaloid, by chemical, spectrophotometric and chromatographic methods. One of the products has been identified as γ-keto-γ(3-pyridyl)butyric acid, first isolated by Wada and Yamasaki[3]. A second substance, characterized by two ultra-violet absorption maxima (230 and 290 mμ), appears to be a substituted pyridone. Two additional substances have the properties of glutaconic acid derivatives, and the final degradation products are ammonia, methylamine and simple aliphatic dicarboxylic acids. The successive appearance of these substances indicates that the degradation starts with the oxidative opening of the pyrrolidine ring of the nicotine molecule, and proceeds with the oxidative rupture of its pyridine moiety, via the intermediate formation of pyridones.

Two agents contained in the seed washings are necessary for these effects, namely, (*a*) micro-organisms present on the seed surface, and (*b*) a heat-resistant substance or substances removable by water from the seed. The quantities of (*b*) required for continuous degradation of nicotine increase with the concentration of the nicotine solution.

Air-borne micro-organisms can replace, under certain conditions, the micro-organisms obtained from the seed; but they also require for continuous action the heat-resistant supplement (*b*).

This deep-seated chemical destruction of nicotine under the influence of agents associated with tobacco seeds might be in some way related to the known absence of nicotine and other pyridine derivatives in tobacco seed. Considering the possibility that a reversal of the observed degradation reactions may occur in the presence of a reducing enzyme system and of hydrogen donors, such nicotine formation from simple compounds may represent a model of the natural nicotine synthesis in the tips of the rootlets emitted from the sprouting tobacco seed.

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Identity of the Acetylcholine-like Substance in the Housefly

The hypothesis that the organophosphate insecticides kill insects by inhibiting the cholinesterase of the nervous system has been questioned, partly on the grounds that acetylcholine has not been demonstrated in insects[1]. That insects contain a substance with pharmacological activity similar to acetylcholine has been amply demonstrated[2]; but the identity of this substance remains in doubt. Chemical methods have indicated that the substance is not acetylcholine[3]; on the other hand, combined chromatography and pharmacological methods have indicated that the substance is acetylcholine[4]. We have used the chemical method, chromatography and electrophoresis to examine the pharmacologically active substance extracted from the housefly, *Musca domestica* L. The results show consistently that the acetylcholine-like substance in the housefly is identical with acetylcholine itself.

Flies were decapitated on solid carbon dioxide and the heads (10–15 gm. for each experiment) homogenized in 0·01 per cent eserine. Homogenates were deproteinized with trichloracetic acid, and the supernatant extracted with ether and reduced to dryness *in vacuo*. The residue was extracted with acidified ethanol, and the ethanol removed by a stream of air, leaving a sticky brown residue.

Paper electrophoresis was used for separating the active substance from the extracts. Using lithium sulphate as the electrolyte, two bands moved to the cathode leaving most of the interfering material at the origin. Pharmacological tests, using the frog rectus abdominis, showed activity present in band 2, none in band 1, and only traces on the rest of the paper.

Sections of the electrophoresis strips corresponding to the location of the bands were cut out, eluted and chromatographed. For comparison, we chromatographed reagent acetylcholine bromide, and acetylcholine bromide which had been run parallel with the extract through the electrophoresis procedure. Fig. 1 shows the results. Band 1 (E_1) was resolved as a single compound which other tests, outlined below, indicate to be choline. Band 2 (E_2) was resolved into two components (the faint, lowest spot seems due to incomplete separation from band 1). The identity of the fast-moving component is unknown. The other component had an R_F identical with that of acetylcholine sulphate subjected to the same electrophoresis procedure as the extract. The R_F of acetylcholine bromide was considerably higher;

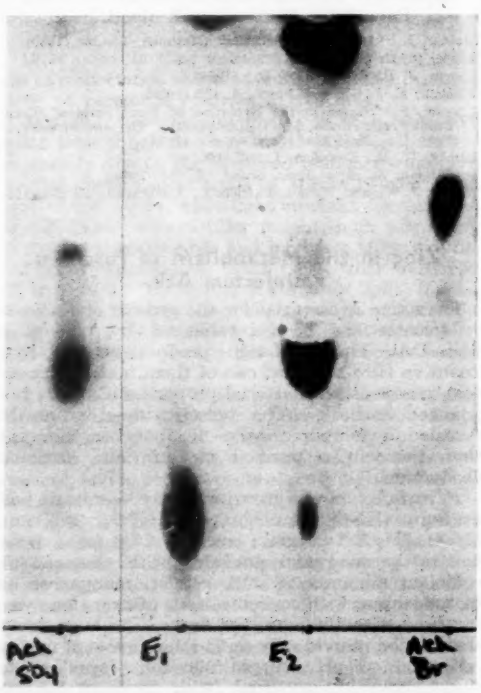

Fig. 1. Paper chromatogram of: eluates from bands 1 and 2 (E_1 and E_2) obtained by electrophoresis of housefly extracts; acetylcholine after electrophoresis in lithium sulphate (ACh SO_4); acetylcholine bromide (ACh Br). Solvent, butanol/acetic acid/water (4 : 1 : 5).. Chromatogram sprayed with phosphomolybdic acid followed by acidic stannous chloride

others[5] have observed that the anion influences the R_F of acetylcholine. It seems reasonable to conclude that the valid comparison is between the extract and acetylcholine treated in the same way, and that this comparison indicates the presence of acetylcholine in band 2. Pharmacological activity was found only in the region of the spot with R_F identical with that of acetylcholine after electrophoresis.

Hestrin's chemical method[6] was applied to eluates from bands 1 and 2. The material from band 2 gave an absorption spectrum identical with that of acetylcholine; band 1 was negative for choline esters.

Paper electrophoresis was used further for examining the active substance separated in band 2. When acetylcholine bromide was added to an eluate of band 2, the mixture moved as a single band without separation. After treatment of uneserinized homogenates with purified bovine acetylcholinesterase, band 2 was absent; on re-electrophoresis, the remaining band 1 showed the same mobility and colour reaction as choline.

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A Reliable Physiological Index for evaluating Summer Clothing

A search for a reliable physiological index to evaluate the comfort of summer clothing was begun during the Second World War and is still being continued. Many indices have been tried for this purpose[1]; but all these can at best reveal significant differences between the clothed and the nude state, or between two grossly different types of clothing. In a preliminary investigation[2] this fact was confirmed.

We have now used an evaporative cooling index suggested by Paintal (personal communication, 1953) which is remarkable for its simplicity and reproducibility and which, in fact, reveals differences that are significant at the 1 per cent level between different types of clothing in everyday use. This index, which is based on the principle that human comfort is related to skin temperature, is expressed as the average drop in skin temperature of the trunk in degrees 6 min. after exposure of the trunk fully covered with sweat to a streamlined flow of air at 300 ft./min.

The experiments were carried out in an air-conditioned room at dry bulb 95·0° ± 1·0° F. and 60 ± 3 per cent relative humidity. Shirts made of three types of fabrics were used: (i) white muslin kurta (a type of Indian shirt); (ii) olive-green bush-shirt of cellular material; and (iii) olive-green bush-shirt of U.K. jungle gaberdine. Olive-green drill trousers were worn in each case. Ten subjects were used for this series of experiments.

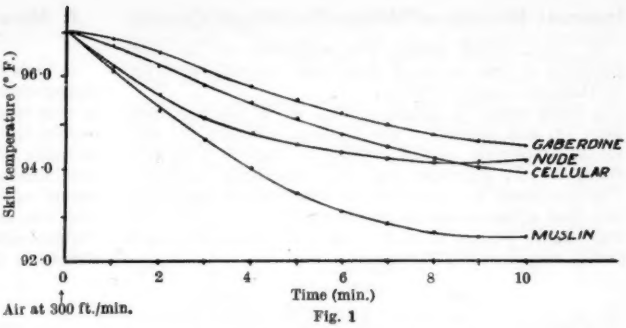

Fig. 1

Thermocouples were strapped to four points on the trunk and the subject then donned the shirt under trial with the standard trousers. He then cycled on a cycle ergometer for 15 min., by which time his trunk was fully covered with sweat. The subject then sat in an erect posture on a stool facing (but shielded from) a source of streamlined current of air at 300 ft./min. Skin temperatures at four points were recorded and the air was turned on his trunk. Thereafter skin temperature was recorded at each point at intervals of 1 min.

Fig. 1 was plotted after averaging sixty readings on ten subjects. For purposes of comparison, the curves have been adjusted to start from the same initial temperature of 97·0° F., as the significant observation was the drop in skin temperature, and the exact initial temperature, therefore, really did not matter. As shown in Fig. 1, the fall in skin temperature by the sixth minute with subjects unclothed and wearing muslin kurta, cellular bushshirt and gaberdine bushshirt were respectively 2·7, 4·0, 2·3 and 1·8 deg. F. Statistical analysis of the whole of the results shows that differences significant at the 1 per cent level occurred between the three types of dresses. It is, therefore, evident that muslin would be the 'coolest' fabric to wear in summer—a point of interest since it has been in use in India for several centuries. The advantage of being mosquito-proof afforded by U.K. jungle gaberdine is probably outweighed by the resistance it offers to cooling of the skin.

Several different types of fabrics have now been tried out, and the results will be reported in detail elsewhere.

We are grateful to Dr. A. S. Paintal for many valuable suggestions and to Mr. N. K. Chakravarty for statistical analysis of the results.

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Internal Friction of White Tin Single Crystal

B. Chalmers[1] noted the existence of α- and β-ranges in the curve of creep-rate versus stress for a white-tin single crystal.

I have made a single crystal of 99·93 per cent pure tin and measured the relation between Q^{-1} and strain amplitude of this crystal at various temperatures by F. Foerster and W. Koester's method[2]. The specimen was 2·5 mm. in diameter, 8 cm. long, and had a fundamental frequency of 1·5 kc./sec. Its axis made angles of 6·3° and 7·2° with [001] and [100], respectively.

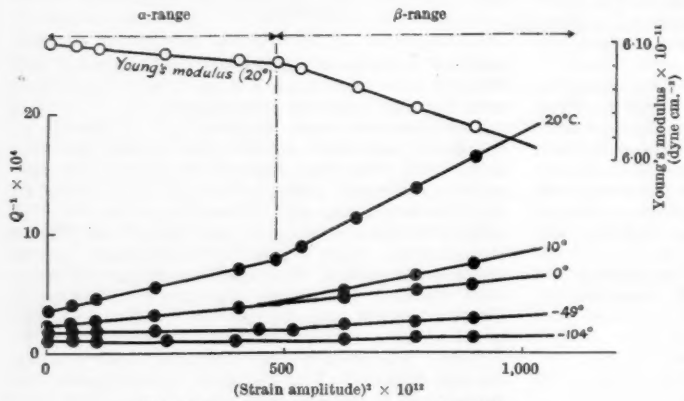

Fig. 1. ●—●—, Q^{-1}; ○—○—, Young's modulus

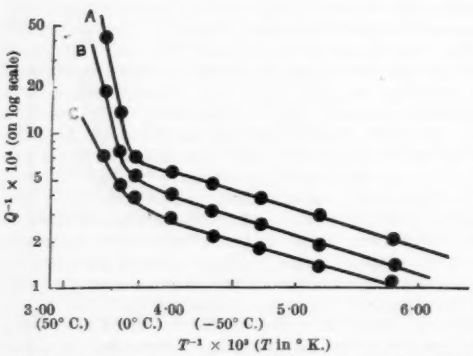

Fig. 2. log Q^{-1} as a function of T^{-1} at the following different strain amplitudes: (*A*) 40 × 10⁻⁶, (*B*) 30 × 10⁻⁶, (*C*) 20 × 10⁻⁶

The critical points in Q^{-1} and Young's modulus curves in Fig. 1 correspond to that in Chalmers's creep-rate curve. In the α-range, Q^{-1} depends on the strain amplitude at higher temperatures, but its dependency is small at lower temperatures.

As seen in Fig. 2, at low temperatures the relation between log Q^{-1} and $1/T°$ K. is linear; but this is not the case above the recrystallization temperature.

A more detailed description of this work will be published elsewhere. I thank Prof. T. Okuda for his guidance.

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Dec. 20.

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A New Method for measuring Electrical Resistivities

A new method for the measurement of electrical resistivities of conductors has recently been developed in this laboratory by inducing a momentary electromotive force in a plane uniform ring of the conductor suitably suspended in a homogeneous magnetic field and observing the resultant ballistic throw. In the actual experiments, the field was horizontal and the ring was suspended from a torsion fibre with its plane vertical and with its axis at an angle of 45° to the direction of the field. When the field is switched off in an interval of time very small compared to the time-period of the suspension, the ballistic kick θ is given by

$$\theta = \frac{A^2TH^2a}{8\pi I\rho L}$$

in which I is the moment of inertia and T the period of oscillation of the suspension, A is the area of the ring, a the area of its cross-section and L its circumference, H is the magnetic field, and ρ is the resistivity. (The effect of the field on the resistivity is ordinarily negligible.)

This expression has been used by us for determining the resistivity of copper at room temperature. The result obtained, namely, 1·83 × 10⁻⁶ ohm cm. at 25° C., agrees well with the known value of the resistivity of copper. The method will be particularly useful for investigating conductors to which terminals are difficult to attach.

We thank Sir K. S. Krishnan, director of the National Physical Laboratory of India, for his interest in this work.

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Focusing of Waves in Radio Reception

The normal maximum field-strength in Kent of the broadcast transmission on 9,700 kc./s. (30·93 metres) from Sofia in undisturbed propagation conditions, and at times of the evening or night when 9·7 Mc./s. is about the optimum working frequency for the transmission path by single refraction in the *F*·2 layer, is about 1·0–1·5 millivolts per metre (Fig. 1). The aerial power of the Sofia transmitter is believed to be 120 kW. approximately, and the calculated quasi-maximum field-strength in conditions of minimum absorption agrees fairly closely with this field-strength being obtained at the path-distance involved.

In late 1952, an isolated observation was recorded by chance, in which the strength of Sofia appeared very greatly to exceed the normal value. Other similar abnormally high field-strengths were observed in 1953. In May and June a special watch was kept

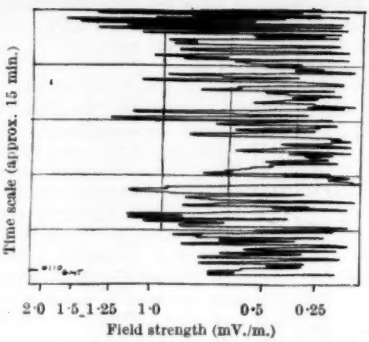

Fig. 1. Recording of normal peak reception from Sofia on 9,700 kc./s. on June 15, 1953, from 0110 hr. G.M.T.

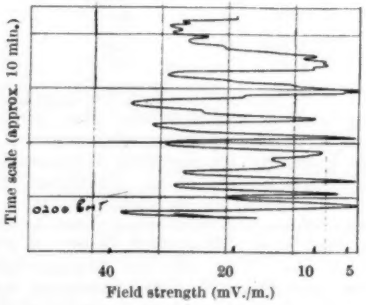

Fig. 2. Example of 'focused' reception from Sofia on 9,700 kc./s. on June 25, 1953, from 0200 hr. G.M.T.

for these occurrences, in which the field-strength received was considerably greater than that to be expected if only the inverse-distance law were taken into account, neglecting absorption. The phenomenon was then noted on only three nights in twenty-nine and its duration was from ten to twenty minutes approximately. Before the exceptional condition occurred, the field-strength increased slowly in the normal manner to the usual 1–1·5 millivolts/metre 'peak' value, remaining at about this figure for about an hour. Then the strength again improved rapidly to the 'abnormal peak', during which peak measurements of 20–30 millivolts/metre were not uncommon, with intervening troughs of fading (Fig. 2). Finally, the signal weakened rapidly, becoming stabilized for a few minutes about the normal high value around 1 millivolt/metre and then declining quickly toward much lower strengths of about 50 microvolts/metre. This final decline was a normal condition in the early morning, probably as the signal began to penetrate the *F*-2 layer, because the frequency was about the maximum usable frequency. Only the high 'abnormal peaks' were in any way unusual or unexpected.

Field-strength recordings were made of the normal and abnormal maximum fields on different nights, and the information was given to some other interested workers, special observations being discontinued thereafter. The phenomenon continued to be evident at intervals, though perhaps rather less often than the 10 per cent of nights noted above. More recently, abnormal peaks around 22 millivolts/metre were measured in the period 0415–0425 G.M.T. on November 30, 1954.

The effect has been ascribed to some form of ionospheric 'focusing'; but the increase in strength by a factor of about 20 : 1 (which would correspond with an effective power increment of four hundred times the normal) seems extraordinarily large. It has been observed on other transmissions from the eastward, but very rarely and in a less pronounced degree, suggesting that the most favourable condition for such focused propagation is from the south-eastward.

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Thunderstorm Signals at Very-high Frequency and Ultra-high Frequency

WHILE signals from distant very-high and ultra-high frequency transmitters were being monitored on June 26, 1954, a thunderstorm occurred in the region of the receivers. The transmitters, which operated at 49, 91, 173 and 492 Mc./s., were some two hundred miles from the receiving site. Fig. 1 shows a portion of the signal amplitude records obtained during the storm. The speed of response of the receivers was limited by one half-second time constant of the recorders. A single five-element Yagi antenna was used with each of the 49, 91 and 173 Mc./s. receivers, and a twelve-foot paraboloid reflector antenna was used with the 492 Mc./s. receiver. All antennæ were horizontally polarized and were directed towards the transmitters.

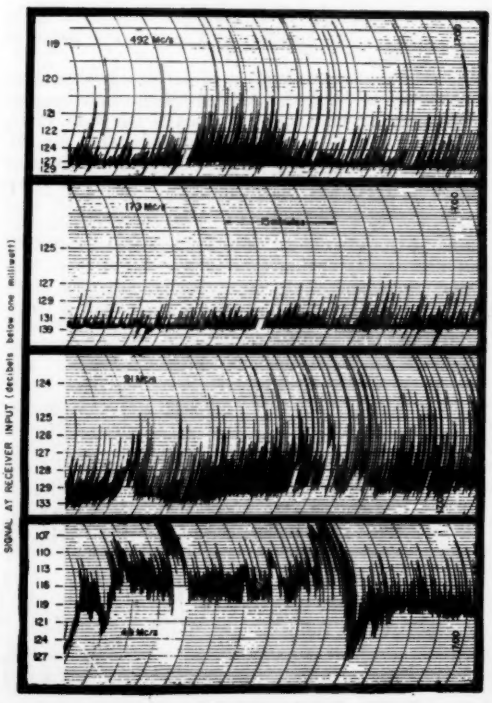

Fig. 1

Although other reports on very-high and ultra-high frequency signals during a thunderstorm have been published recently[1], it is believed that these are the first records which offer a comparison of the relative amplitudes over a wide part of the spectrum. The normal, slowly fading signals changed into a continuing series of rapid impulses during the storm. Although the 91 and 173 Mc./s. transmissions stopped during the storm, there was no apparent change in the nature of the records at that time. Further, the hourly silence period in the 49 and 492 Mc./s. transmissions was not recorded during the storm. It would appear that most of the recorded signals were due to noise originating from the thunderstorm rather than signal from the distant transmitters.

This work was carried out under project *PCC D48-28-01-03*.

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Defence Research Board,
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Jan. 28.

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Infra-red Spectrum of the Night Sky near 10000 A.

We have recently obtained infra-red spectra of the night sky using the newly improved Kodak *IZ*(2) plates. An exposure of 48 hr. was sufficient to bring up a considerable number of lines on a hypersensitized plate. An $f/0{\cdot}8$ auroral spectrograph described elsewhere[1] was employed. A microphotometer tracing of a typical plate is shown in Fig. 1. The spectral slit width was 4·5 A.

The measured wave-lengths of the stronger features are recorded in Table 1. Almost all the features can be attributed to lines and branches of the (5,2), (4,1), (3,0), (9,5) and (8,4) OH rotation-vibration bands. The predicted wave-lengths (in air) for the lines of the (5,2), (4,1) and (3,0) bands were calculated from the energy-level data of Dieke and Crosswhite[2] and of Herman and Hornbeck[3]. The predicted wave-lengths of the $Q(1)$, $P_1(2)$ and $P_1(3)$ lines of the (9,5) band and the $Q(1)$ line of the (8,4) band were calculated by means of the combination principle from the wave-lengths of the observed lines of the (9,4), (4,0) and (5,0) bands[4,5]. The wave-lengths of the remaining lines of the (9,5) and (8,4) bands were calculated by means of the extrapolated B, Y and D values given by Herman and Hornbeck[3]. The calculated wave-lengths of the rotational lines are given in Table 1 and are indicated in Fig. 1.

Table 1. Wave-lengths of Night Sky Emissions 9500 A.–11000 A.

(Air) A.	Identification	(calculated; air) A.	obs.–calc. A.
10972·2	$P_1(3)$ (5,2) OH	10972·3	−0·1
10923·3	$P_1(2)$ (5,2) OH	10923·3	0·0
10831·6	$Q(1)$ (5,2) OH	10831·6	0·0
10750·2	$R_1(1)$ (5,2) OH	10751·0	−0·8
10730·0	$R_1(2)$ (5,2) OH	10729·0	+1·0
10709·5	$R_1(3)$ (5,2) OH	10711·4	−1·9
10470·0	$P_1(4)$ (4,1) OH	10469·1	+0·9
10419·4	$P_1(3)$ (4,1) OH	10418·4	+1·0
10396·3	$P_1(3)$ (4,1) OH	10396·8	−0·5
10372·3	$P_1(2)$ (4,1) OH	10373·0	−0·7
10348·3	$P_1(2)$ (4,1) OH	10347·5	+0·8
10287·5	$Q(1)$ (4,1) OH	10286·9	+0·6
10228·0	$R_1(1)$ (4,1) OH $P_1(5)$ (9,5) OH	10230·7 10224·3	
10209·9	$R_1(1)$ (4,1) OH	10211·2	−1·3
10190·9	$R_1(2)$ (4,1) OH	10190·0	+0·9
10172·0	$P_1(4)$ (9,5) OH	10171·4	+0·6
10125·1	$P_1(3)$ (9,5) OH	10124·9	+0·2
10086·4	$P_1(2)$ (9,5) OH	10087·9	−1·5
10015·1	$Q(1)$ (9,5)	10013·9	+1·2
9951·0	$R_1(1)$ (9,5) OH $R_1(2)$ (9,5) OH	9958·7 9946·9	
9917·2	$P_1(3)$ (3,0) OH	9915·6	+1·6
9895	$P_1(3)$ (3,0) OH	9897·1	−1·9
9874·7	$P_1(2)$ (3,0) OH	9872·3	+1·4
9848	$P_1(2)$ (3,0) OH	9849·4	−1·4
9796	$Q(1)$ (3,0) OH	9791·6	+4·4
9485	$P_1(3)$ (8,4) OH	9483	+2·0
9381	Q (8,4) OH	9383	−2·0
9320	$R_1(1)$ (8,4) OH $R_1(2)$ (8,4) OH	9330 9319·3	

Spectra in this region have been previously obtained by Krasovski and Lukashenia[6], using an infra-red image converter. Krasovski and Lukashenia[6,7] discussed the identification of the emissions with the OH rotation-vibration bands and concluded that the agreement was not altogether satisfactory.

The present work, as may be seen from Table 1 and Fig. 1, indicates excellent agreement between the observed and calculated wave-lengths for the OH bands.

As noted by Krasovski and Lukashenia, the Q branch of the (3,0) band seems to be abnormally weak. It is definitely present, however; moreover, the lines of this band have the same appearance as those of the other OH bands. The R branch of this band also appears to be present in the microphotometer trace. Many other weaker features in the microphotometer trace correlate well with the calculated spectrum.

The diffuse feature at 9951 A. has about the same intensity as the Q branch of the (9,5) band at 10015·1 A., whereas the R branches of the (5,2) and

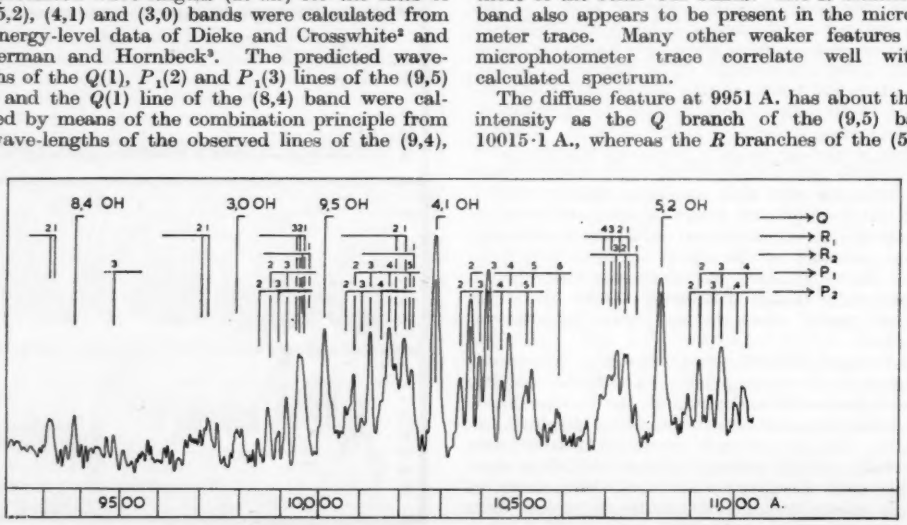

Fig. 1

(4,1) bands are considerably weaker than the Q branches. This effect seems, however, to be a consequence of the more rapid convergence of the lines of the R branch of a $\Delta v = 4$ band compared with the $\Delta v = 3$ bands. There is no evidence that the (0,2) atmospheric oxygen band (9967 A.) is present with any intensity, since this band should give rise to maxima near 9948 and 9986 A.

It is also satisfactory to note that there is no sign of the (10,6) band, which would fall in this region if it were present.

In view of the general appearance of the bands and of the excellent agreement between observed and calculated wave-lengths, there can be little doubt that the night-sky emission in this region is almost entirely due to the OH rotation-vibration system.

The investigation reported here has been sponsored by the Geophysics Research Directorate of the Air Force Cambridge Research Center, Air Research and Development Command, under Contract *AF* 19(122)-152.

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[1] Petrie, W., and Small, R., *Astrophys. J.*, **116**, 433 (1952).
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Identification of Water-Masses by their Suspended Matter

In the often very difficult task of following the movements of coastal and oceanic water masses, much use has been made of the temperature, the salinity and the amount of oxygen in solution. In special cases the concentrations of silica or of hydrogen ions may give useful information.

The transparency is important, and Jerlov's brilliant work on the Swedish Deep Sea Expedition of 1947–48, and in Swedish coastal waters, has shown the great value of the visual determination of the scattering of light in the Tyndall beam as a guide to the amount and type of suspended matter. Poole and Atkins, too, have studied this scattering using a photomultiplier tube, set at various angles to the beam, the light of which they found was mainly scattered forward.

During September 1951–July 1954 we filtered water, usually two litres, from station *E*1, 10 miles south-west of the Eddystone, through collodion ('Gradocol') disks. Photographs of such disks were prepared[1], and we pointed out that the diffuse reflexion (albedo) of the disks relative to a similar disk treated with distilled water was a good measure of the amount of suspended matter. Save during a phytoplankton outburst, the intensity and colour of the disks were only slightly influenced by the living cells, which if necessary can be decolorized in 80 per cent aqueous acetone.

The basis of the suspension was an amorphous mud, usually some shade of grey. The albedo was determined photoelectrically; and using blue, green and red light filters we obtained colour factors also[2]. But with the aid of colour charts, such as those of Klincksieck and Valette, or of Ridgway, such as could quite easily be used at sea, we were also able to describe the grey, yellowish or even chocolate colour of the disks, various samples matching Klincksieck's[3] Nos. 115–120, 128, 142, 147, 153*D*, and Ridgway's[4] Plate 3, Nos. 12, 15, 18, 19, 20, 23. In October 1952 and 1953, the light buff to chocolate tint was observed when the water had become isothermal. This is probably due to a ferruginous suspension, such as might have come from the Lower Old Red Sandstone of the nearest land or—as it appeared infrequently—from the Permian Red Sandstone between Torquay and Exmouth.

The petrological examination of the suspended matter has been undertaken by Dr. A. G. Lowndes, who kindly identified some of the particles for us. Especially important was his finding of the very insoluble microcline on disks from station *E*1, on March 29, 1954. Its refractive index is low, 1·52. It was most abundant on the 5-m. disk; this suggests that it had come out in fresh water and was slowly settling. He directed our attention to the fact that this mineral has one cleavage plane developed more strongly than the other two, and so tends to split into small plates which settle only slowly. Such suspended matter may therefore be carried very far from land, as may also the fine amorphous suspension, which Dr. Lowndes found to be kaolin.

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Jan. 18.

[1] Atkins, W. R. G., and Jenkins, Pamela G., *J. Mar. Biol. Assoc. U.K.*, **31**, 503, Fig. 8 (1953). Atkins, W. R. G., Jenkins, Pamela G., and Warren, F. J., ibid., **33**, 501, Fig. 1 (1954).
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Antioxidant Activity of Redox Dyes

Further evidence has been obtained to support the hypothesis that certain redox dyes, having partial vitamin E activity, can inhibit the catalytic action of hæmatin in the oxidation of unsaturated fats[1].

It has previously been shown[2] that methylene blue inhibits *in vitro* hæmatin-catalysed oxidation of unsaturated fats. In the present work the effect of new methylene blue, malachite green, rosaniline, Bindschedler's green and methyl violet on the rate of cod-liver oil oxidation catalysed by 5×10^{-4} *M* hæmatin, at 37° C., was determined by this same method[2]. The concentration of each dye causing inhibition of the oxidation reaction is given in Table 1. These results demonstrate that all these

Table 1. Inhibition of Hæmatin-catalysed Oxidation of Cod-Liver Oil by Redox Dyes

Redox dye	Conc. of dye, $\times 10^{-4}$ *M*	Inhibition (per cent)
Malachite green	12·5	26
Rosaniline	9·2	50
Methyl violet	8·7	50
New methylene blue	6·5	50
Bindschedler's green*	6·4	50

* Dissolved in 25 per cent (vol./vol.) aqueous pyridine.

dyes are relatively good inhibitors of *in vitro* hæmatin-catalysed oxidation of unsaturated fat.

Since the hæmatin compounds are the predominant catalysts occurring in animal tissues[2] for the oxidation of unsaturated fats, the ability of these redox dyes to replace vitamin E in the diet of rats is probably a function of their antioxygenic properties, and more specifically, of their inhibitory effect on the hæmatin-catalysed oxidation of unsaturated fats.

Hæmatin is capable of chemical combination with many nitrogenous bases, through its iron atom, to form hemichromes. It is probable that these redox dyes, all of which contain basic nitrogen atoms, react with hæmatin to form hemichromes which are not catalytic. The direct interaction of hæmatin with methylene blue is also indicated by the fact that the absorption spectrum of a mixture of methylene blue and hæmatin is considerably different from that of the summation of the absorption spectra of the individual compounds.

Besides direct reaction of these redox dyes with hæmatin, two other mechanisms might be operative *in vivo*. The oxidation-reduction potential of most animal tissues and organs is sufficiently negative in comparison to that of the redox dyes to account for the existence of the leuco form *in vivo*. These leuco dyes might function by inhibiting the oxidation of unsaturated fats by terminating the free-radical chain-reaction. Alternatively, the dyes might serve to regenerate α-tocopherol from a reversible oxidation product, like α-tocopheroxide, and thus allow the re-use of otherwise subminimal amounts of vitamin E.

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Jan. 5.

[1] Moore, T., Sharman, I. M., and Ward, R. J., *Biochem. J.*, **53**, xxxi (1953); **54**, xvi (1953); **58**, vii (1954); *Proc. Nutr. Soc.*, **12**, v (1953).
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An Optically Active Spirocyclic Phosphonium Salt

The tetrahedral disposition of the 4-covalent phosphorus atom has been confirmed by the optical resolution of (*a*) a tertiary phosphine oxide, of type *abc*PO, by Meisenheimer *et al.*[1], (*b*) a tertiary phosphine sulphide, *abc*PS, by Davies and Mann[2], and (*c*) a quaternary phosphonium salt, [*abcd*P]I, by Holliman and Mann[3]. No spirocyclic phosphonium salts, in which the two ring systems consist solely of carbon atoms apart from the phosphorus atom which is necessarily common to both, have, however, hitherto been recorded.

The comparatively ready synthetic methods by which analogous spirocyclic arsonium salts[4] have been prepared cannot be successfully applied to the phosphonium salts. By a much longer route, however, we have synthesized *dl*-P-spiro-bis-1 : 2 : 3 : 4-tetrahydrophosphinolinium iodide (I), melting point 294–295°. The optical resolution of this dissymmetric cation has been achieved by the fractional crystallization of its *l*-menthoxyacetate, and we have thus isolated the *d*-iodide, melting point 246–248°, $[M]_D$ + 66°, and the *l*-iodide, melting point 246–248°, $[M]_D$ − 65°, both rotations determined in chloroform

(I)

solution. These rotations showed no change after the solution had been set aside at room temperature for four days.

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Cambridge.
April 2.

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Correction of 'Crude-Fibre' Estimation for the Effect of Altitude

In the estimation of crude fibre at altitudes appreciably above sea-level, it is necessary to correct for lowered boiling points of reagents and consequent reduced speeds of reaction. When Todd[1] estimated crude fibre in ten samples of plant materials at sea-level and at 6,200 ft., he calculated the percentage error involved in each instance and proposed three ways of correcting, namely: (1) by increasing the duration of the boiling; (2) by increasing the concentration of acid and alkali; (3) by carrying out the estimation by the standard procedure and applying a correction factor.

An examination of the first proposal was made by me in Nairobi, at an altitude of 5,700 ft. Twelve samples of plant material of varying fibre content were digested with 1·25 per cent acid and with 1·25 per cent alkali for periods of 15, 30, 45, 60, 90 and 180 min. Results showed that there is a highly significant inverse relationship between the logarithm of the time allowed for digestion and the resulting crude-fibre fraction of the material. In Nairobi, the reagents boil at 94·3° C., and a digestion period of 45 min. gives crude fibre values which do not differ significantly from those obtained by the conventional 30 min. digestion at sea-level: a calculated digestion period of 45·6 min. appears to give optimum correlation.

The following equation has been evolved to correct for lowered boiling points at higher altitudes by increasing the duration of the digestion period:

$$\text{time of digestion (min.)} = 30 \times 10^{(100° - t°)0.032}$$

where $t°$ C. is the boiling point of the reagents.

Alternatively, the regression equation to correct the conventional 30 min. digestion value will be:

$$\text{crude fibre (corrected)} = \text{crude fibre (30 min. at } t°) \times [1 - (100° - t°)\ 0{\cdot}0102]$$

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Feb. 2.

[1] Todd, J. R., *Nature*, **168**, 76 (1951).

A Modified Method of Filter Paper Electrophoresis

In the course of our work on the separation of protein fractions from wheat gluten by means of paper electrophoresis, it was found that good resolution of hitherto unresolved fractions could be achieved by paper electrophoresis using long paper strips and high voltages over an extended period of time. This method does not require an organic cooling liquid, such as monochlorobenzene[1]. It may be useful for the separation of enzyme mixtures, where contact with organic liquid may inactivate the enzymes.

In this method, the filter paper strip is wrapped, spiral fashion, around a glass tube, 22 in. long and ¾ in. external diameter, through which cold water is running (Fig. 1). To minimize evaporation from the strip, it is covered with a strip of thin 'Cellophane' of the same width. Humid conditions are maintained by enclosing a portion of the glass tube in a wooden box, which is lined with filter paper saturated with buffer. The ends of the filter paper, covered by 'Cellophane', pass in and out of the humid chamber by way of two narrow slits at the bottom, ¾ in. from each end. 'Cellophane' sleeves, attached to the chamber and terminating below the level of the buffer solutions, prevent the drying out of these portions of the strips.

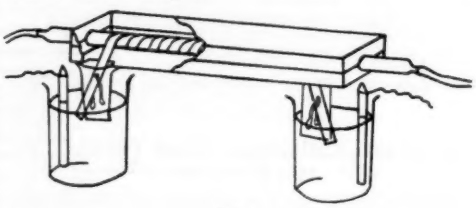

Fig. 1

Before use, the glass tube is treated with silicone grease. The filter paper strip is then passed through one sleeve, to which it is clamped with a paper clip, and wrapped tightly around the glass tube, passing out through the sleeve at the other end and clamped fast. To permit wrapping at an angle, the 'Cellophane' sleeves—through which the paper strips pass—are slit along the outside edge leaving a short uncut portion adjoining the box. At one end, together with the filter paper strip, a 'Cellophane' strip of the same width as the filter paper is clamped in. The point of application for the protein mixture is then marked on the paper and the buffer painted on with a brush. This procedure prevents tearing and bruising of the paper, which may occur when a buffer-moist, blotted strip is wrapped tightly around the glass tube. The substance is then applied to the marked line and the 'Cellophane' strip wrapped tightly so as to cover the whole length of the strip and to pass out through the second sleeve. The 'Cellophane' sleeves, filter paper and 'Cellophane' strip are then pierced and weighted with a piece of bent glass rod and the paper clips removed. The buffer vessels and the carbon electrodes are then placed in position below the chamber.

In our experiments, strips of Whatman 3*MM* paper, 60 cm. long and 2·5 cm. wide, were used. For a run of 24 hr. with a potential gradient of 9 V./cm., 2 × 2 litres of McIlvaine's buffer *p*H 2·07 and ionic strength of 0·025 were used. Unless high voltages are used (17 V./cm.), no condensation of water on the exposed surface of the glass tube takes place; but even where this happens, loss of substance through migration off the paper rarely occurs. The 'Cellophane' covering the strip prevents the redepositing of moisture on the filter paper. Protein spots obtained by this method are sharp and as well defined as spots obtained in electrophoresis between glass plates.

The full results of this investigation will be published elsewhere.

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[1] Consden, R., *Nature*, **170**, 1069 (1952).

Isolation of Fungi from Hyphæ present in Soil

While it is known that fungi may exist in soil both as active mycelium and as dormant spores[1], a major problem in the study of soil fungi has been to discover which fungi in a soil are present as mycelium. Plating methods by which fungal colonies are isolated from soil[2] or from soil suspensions[3] on agar media suffer from the disadvantage that the unit of origin, spore or hypha, of the resulting colonies is not known. Direct microscopic examination, either of Rossi–Cholodny slides or soil films[4], has the complementary deficiency that although fungal hyphæ are seen, most are sterile and their identity cannot be investigated. I have devised a simple technique for the isolation of fungi directly from hyphæ present in soil. Essentially the method depends on the observation that when a soil suspension is prepared, many of the fungal hyphæ remain with the heavier soil particles of the residue. Removal of the fine suspended material from the residue also permits visual examination of the latter for the presence of individual hyphæ or hyphal masses, which may then be removed and grown on agar media.

A soil crumb of about 1·0–1·5 gm. is placed in a beaker part-filled with water and left to become saturated. After 4–5 min. the crumb is broken apart by filling the beaker with a rapid jet of tap water. The heavier soil particles are allowed to sediment for 1·0–1·5 min. and then most of the suspension is poured off. Further water is added, the heavier particles allowed to sediment and the suspension again removed. This procedure is continued until the liquid remains clear after standing for 1·0–1·5 min. The soil particles of the residue are then distributed in a small quantity of water among three sterile Petri plates and searched for the presence of fungal hyphæ using a binocular dissecting microscope (× 12·5 and × 25). Individual hyphæ or portions of hyphal masses are removed with fine forceps from among the soil particles and are placed in a drop of sterile water on a clean sterile isolation plate.

Since many fungal hyphæ isolated from soil are attached to mineral grains or to humus particles on or in which contaminating fungi and other microorganisms may be present, it is desirable to remove as many as possible of these attached particles. Many may be removed by gently tapping the hypha against the bottom of the plate; others cannot be removed without killing the hypha. Hyphal masses may also need to be teased out, since they usually consist of more than one species of fungus. When sufficient hyphæ (usually 20–50) are on the plate, it is poured with melted but cooled agar and the hyphæ

dispersed by shaking and rotating the plate before the agar solidifies. Hyphæ are then located, ringed and numbered on the reverse of the plate. Plates are incubated at room temperature and examined daily under a microscope (× 120) for fungal growth.

Most hyphæ show growth by the second or third day; some, however, show no definite growth until 7–9 days after preparation of the isolation plate. All clean hyphæ showing growth are cut out in an agar block and transferred to fresh medium; sometimes hyphal tips only are removed. In many cases, particularly where humus particles are attached to a hypha, care is needed to be certain that the growth arises from the hypha and not from a humus particle. In these cases it is advantageous to remove the hypha in an agar block and examine it on a sterile slide at a higher magnification. If the origin of growth remains uncertain the block is discarded. It is also necessary to cut out any fungi developing from spores or humus particles on the isolation plates, to prevent them overgrowing ungerminated or slow-growing hyphæ.

Several media have been investigated, the most useful of those tested being Dox+yeast agar (*p*H 5·6–5·8) diluted to one-sixth of its normal strength[3]. Prerequisites for a good isolation medium are that it be transparent and that it prevents excessive growth of bacteria and Actinomycetes, particularly those that occur along the walls of the fungal hyphæ. The addition of ammonium salts, of peptone, of soil extract, of hydrolysed casein, and of higher concentrations of yeast extract has stimulated the growth of some hyphæ isolated from soil, but has encouraged increased growth of contaminating bacteria or Actinomycetes. The medium was not highly acidified, since it was noted that some hyphæ were sensitive to low *p*H. Some hyphæ isolated from soil, however, grew no further than 50–100μ on the weak Dox+yeast agar or on any other medium tested.

This direct hyphal isolation method has proved useful in the isolation of the root pathogen *Rhizoctonia solani* from soil without the use of a host plant. This fungus has been isolated from many soils where its presence has been known from plant disease, and also from other soils where its presence was not suspected. The method, together with the dilution plate method, is also being used in a study of the ecology of the soil fungi occurring in a wheatfield at the Waite Institute, Adelaide. In this study some eighty species of fungi have been isolated by the direct hyphal method; by far the majority of them, even when shown to be abundant in soil as mycelium, were absent from dilution plates prepared from the same soil samples. The fungi isolated from hyphæ fall into two broad groups: (*a*) fungi such as *Pythium*, *Rhizopus*, *Mortierella*, *Alternaria* and *Fusarium*, which are also frequent on dilution plates; (*b*) a large group of non-sporing fungi which are rare or absent from dilution plates. Several Basidiomycetes are included in this second group. These results indicate that the direct hyphal method isolates a large group of fungi that have hitherto been neglected in soil fungal studies. This work is continuing and will be published in detail elsewhere.

J. H. Warcup

Waite Institute,
Adelaide. Jan. 10.

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[2] Warcup, J. H., *Nature*, **166**, 117 (1950).
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Elminius modestus Darwin, a Northward Extension of Range

Since the discovery of the Australasian barnacle *Elminius modestus* Darwin in the south of England in 1945[1] (with further evidence of a previous settlement in 1943[2]), its rate of spread has been well documented[3]. It is therefore of interest to record the discovery of a single living specimen at Farland Point, Isle of Cumbrae, Scotland, on March 7, 1955. The nearest record to the present one, 55 miles south at Stranraer, Wigtownshire, was in 1950[4].

The particular boulder to which it had attached, just above the level of low water of neap tides, has fortunately been under observation for two years. It was completely bare of barnacles before the settlement of *Balanus balanoides* began in May 1954. The *Elminius* must therefore have become attached during the summer or autumn of 1954; its small size (3·5 mm. carino-rostral length) confirms this. A careful search of the immediate area and several other localities on the island has failed to produce another specimen.

Joseph H. Connell

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University of Glasgow.
March 18.

[1] Bishop, M. W. H., *Nature*, **159**, 501 (1947).
[2] Stubbings, H. G., *Nature*, **166**, 277 (1950).
[3] Most of the relevant literature is cited in Bishop, M. W. H., *Nature*, **167**, 531 (1951), and Kühl, H., *Helgöland. Wiss. Meeresunters*, **5**, 53 (1954).
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A Chiton, *Callochiton fulvus* (Wood), in the River Fal

There is much recent evidence for the spread of marine organisms as fouling on ships' bottoms. *Crepidula fornicata* has been found in the River Fal, Cornwall, since 1947[1], usually in the vicinity of moored ships. An extensive oyster fishery exists in this estuary, and the dredgermen and bailiff have been alive to the danger of the spread of *Crepidula*. This has resulted in a general interest in organisms other than oysters found during dredging. Recently, a large chiton was sent to me by Mr. P. P. Guy, the oyster bailiff. This proved to be *Callochiton fulvus* (Wood), the known distribution of which is Portugal, Spain and South America. This specimen was alive and attached to an oyster shell when caught; it had a length of 5·5 cm. It was taken in a dredge on the edge of the deep-water channel (3–4 fathoms) in Tolverne Reach, a stretch used for many years for mooring oil tankers while temporarily laid up.

It is known that other marine species from the Iberian coast live and grow in British waters. For example, Portuguese oysters (*Gryphaea angulata*) are imported and laid commercially in British estuaries, but water temperatures are rarely sufficiently high to promote spawning. Probably other southern forms have been and will be introduced, and may live in British waters for a while without becoming established.

The specific identification of the *C. fulvus* by Mr. S. L. Wilkins of the British Museum (Natural History) is acknowledged with thanks.

R. H. Baird

Fisheries Experiment Station,
Conway, North Wales. Jan. 20.

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, May 31

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Prof. A. C. Fraser: "Studies on Intestinal Function in Man" (Almroth Wright Lecture).

Wednesday, June 1—Friday, June 3

IRON AND STEEL INSTITUTE, and the INSTITUTE OF METALS (jointly with the AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS and the AMERICAN SOCIETY FOR METALS), at Church House, Westminster, London, S.W.1)—London sessions of the Joint Metallurgical Societies' meeting in Europe.

Wednesday, June 1—Saturday, June 11

BRITISH PLASTICS EXHIBITION AND CONVENTION (organized by *British Plastics*, Associated Iliffe Press, and the Plastics Institute, at Olympia, London, W.14).*

Thursday, June 2

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND (in the Henry Florence Hall of the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 2.30 p.m.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Dr. C. E. K. Mees: "Leo Hendrik Baekeland and Photographic Printing Papers" (Baekeland Memorial Lecture).

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. H. C. Brown (Purdue University): "Chemical Effects of Steric Strains".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PROFESSOR OF THE ARCHÆOLOGY OF THE ROMAN EMPIRE—The Registrar, University Registry, Oxford (June 2).

ASSISTANTS (2) IN MATHEMATICS—The Secretary, The University, Aberdeen (June 3).

WELLCOME VETERINARY RESEARCH FELLOWS for research in connexion with veterinary science or medicine—The Scientific Director, The Animal Health Trust, 14 Ashley Place, Westminster, London, S.W.1 (June 3).

ASSISTANT EXPERIMENTAL OFFICER IN THE GENETICS DEPARTMENT to be responsible for the maintenance of genetic stocks and to assist the Head of the Department—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (June 4).

ASSISTANT LECTURER, Grade A (with graduate qualifications and preferably some teaching experience), principally for teaching biology and some elementary chemistry, at the Municipal Technical College of Science and Art, Blackburn—Chief Education Officer, Education Offices, Library Street, Blackburn (June 4).

ASSISTANT (with a degree in chemistry or equivalent qualification and preferably with teaching and/or industrial experience) TO TEACH CHEMISTRY at the College for Further Education, Grimsby—The Director of Education, Education Office, Eleanor Street, Grimsby (June 4).

INORGANIC CHEMISTS AND PHYSICISTS, Assistant Experimental Officer grade (with G.C.E. (advanced level) in two scientific subjects or equivalent; if over 22 preferably with a pass degree, H.N.C. or equivalent) in the Department of Scientific and Industrial Research, Water Pollution Research Laboratory, Stevenage, Herts, for research on problems of polluted rivers and the treatment of polluting liquids—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.300/5A (June 4).

LECTURER (specially qualified to lecture on petrology and/or X-ray crystallography) IN GEOLOGY—The Registrar, King's College, Newcastle-upon-Tyne (June 4).

LECTURER (with a degree in physics and suitable teaching experience) IN PHYSICS, and an ASSISTANT, Grade B (with a degree in physics and suitable teaching experience) IN PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (June 4).

LECTURER (with special interests in fluid mechanics) IN ENGINEERING, and a LECTURER (preferably with special interests in the theory of structures) IN CIVIL ENGINEERING—The Registrar, King's College, Strand, London, W.C.2 (June 4).

SCIENTIFIC OFFICER (preferably with previous research experience) IN THE CHEMISTRY DEPARTMENT, for work on the physical chemistry of soils—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (June 4).

SCIENTIST, Grade II (with a good honours degree or equivalent, with the main qualification in chemistry, and preferably with experience in the analysis of solid fuels) on the Staff of the Director of Scientific Control at London Headquarters, to maintain close liaison with scientists in the coalfields, and to deal with questions concerning the analysis of coal, mine air, etc.—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/975 (June 4).

LECTURER (with an honours degree in physics, and preferably with industrial experience) IN PHYSICS—The Principal, Wigan and District Mining and Technical College, Wigan (June 6).

LECTURER (with particular interest in elasticity, structures or hydraulics) IN ENGINEERING (Civil)—The Registrar, The University, Manchester 13 (June 6).

SENIOR LECTURER OR LECTURER IN ZOOLOGY, and a LECTURER IN EDUCATION at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (June 6).

MATHEMATICIAN (with a good honours degree in mathematics and a suitable qualification in statistics) IN THE AGRICULTURAL RESEARCH COUNCIL'S UNIT OF BIOMETRICAL GENETICS attached to the Department of Genetics, University of Birmingham—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (June 7).

ASSISTANT ANALYST (with a degree in science or agriculture) IN THE CHEMISTRY DEPARTMENT, West of Scotland Agricultural College, Auchincruive, near Ayr, for work mainly relating to the analysis of agricultural materials other than soils—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (June 8).

LECTURER IN GREEK ARCHÆOLOGY AND ANCIENT HISTORY—The Registrar, King's College, Newcastle-upon-Tyne (June 11).

ASSISTANT LECTURER (Grade II) or DEMONSTRATOR IN PHYSIOLOGY—The Registrar and Secretary, The University, Bristol (June 13).

ASSISTANT LECTURER (with special qualifications in mineralogy and petrology) IN THE DEPARTMENT OF GEOLOGY—The Registrar, The University, Leeds 2 (June 13).

DEMONSTRATOR IN CHEMICAL PHYSIOLOGY—The Registrar, The University, Manchester 13 (June 13).

LECTURER (with an honours degree in civil engineering and practical experience) IN CIVIL ENGINEERING—The Principal, Wigan and District Mining and Technical College, Wigan (June 13).

LECTURERS (2) IN THE DEPARTMENT OF PHYSIOLOGY, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, June 13).

CHAIR OF MATHEMATICS at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, June 15).

LECTURER IN EDUCATION—The Registrar, The University, Nottingham (June 15).

LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY, a LECTURER (preferably with experience in machine design) IN MECHANICAL ENGINEERING, a LECTURER IN ZOOLOGY, and a LECTURER (with special interests in applied mathematics) IN MATHEMATICS, at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 15).

LECTURER IN VETERINARY HISTOLOGY AND EMBRYOLOGY, and a LECTURER IN ANIMAL HUSBANDRY AND PREVENTIVE MEDICINE—The Secretary of University Court, The University, Glasgow (June 15).

PROFESSOR OF MATHEMATICS at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, June 15).

CHEMIST (with either a pass degree or higher national certificate in chemistry) for the mineral analysis of plant materials—The Secretary, East Malling Research Station, near Maidstone, Kent (June 18).

RESEARCH OFFICER (with a university honours degree, with special training and/or research experience applicable to the study of soil fertility problems), at Kimberley Research Station, Land Research and Regional Survey Section, W. Australia, for field and laboratory investigations into problems of soil fertility with tropical crops and pastures grown under irrigation—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (June 18).

SENIOR RESEARCH OFFICER OR RESEARCH OFFICER (with a university honours degree in science or in veterinary science) IN THE DIVISION OF ANIMAL HEALTH AND PRODUCTION, Prospect, N.S.W., Australia, for investigations of digestion in ruminants—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 205/69 (June 18).

CHAIR OF INORGANIC AND PHYSICAL CHEMISTRY, and a LECTURER IN CHEMISTRY, at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Cape Town, June 30).

LECTURER IN MATHEMATICS at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (June 30).

ASSISTANT (with at least a good honours degree in zoology and preferably with qualifications in entomology) IN ZOOLOGY—Joint Clerk to the University Court, Queen's College, Dundee (July 31).

LECTURER IN CHEMISTRY—The Registrar, Hatfield Technical College, Roe Green, Hatfield, Herts.

LECTURER IN INDUSTRIAL METALLURGY—The Registrar, The University, Birmingham 15.

LECTURER (with a university degree in agriculture and some teaching experience) IN AGRICULTURE, at the College of Agriculture, Mauritius—The Director of Recruitment, Colonial Office, 2 Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.63/52/06.

PHYSICIST (basic grade) (with an honours degree and research experience, and preferably with experience in a hospital physics department) IN THE DEPARTMENT OF RADIOTHERAPY (Physics)—The House Governor, Queen Elizabeth Hospital, Birmingham.

PROFESSOR OF MATHEMATICS, a PROFESSOR OF PHYSICAL CHEMISTRY, a PROFESSOR OF CHEMICAL ENGINEERING, and a PROFESSOR OF APPLIED BIOLOGY, at the Israel Institute of Technology, Haifa, Israel—The Secretary, The Technion Society of Great Britain, 83 Wimpole Street, London, W.1.

READER and SENIOR LECTURERS or LECTURERS IN CHEMISTRY—The Dean, College of Arts and Science, Baghdad, Iraq.

RESEARCH ASSISTANTS (2) IN THE DEPARTMENT OF MATHEMATICS AND PHYSICS, for research in the field of vacuum physics and ultrasonics—Head of the Department of Mathematics and Physics, The Polytechnic, 309 Regent Street, London, W.1.

SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS (honours graduates in physics or chemistry) for work which covers a wide range of problems connected with the manufacture and use of ceramic materials—The Director of Research, British Ceramic Research Association, Queens Road, Penkhull, Stoke-on-Trent.

SENIOR LECTURER IN METALLURGY, an ASSISTANT LECTURER (Grade B) IN ELECTRICAL ENGINEERING, an ASSISTANT LECTURER (Grade A) IN STRUCTURAL ENGINEERING, and an ASSISTANT LECTURER (Grade A) IN PHYSICS, at Constantine Technical College, Middlesbrough—The Director of Education, Woodlands Road, Middlesbrough.

SENIOR RESEARCH ASSISTANT (with a good honours degree in engineering, practical experience and/or research training) IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—The Registrar, The University, Nottingham.

TECHNICIAN (preferably with experience in a laboratory workshop and/or in pharmaceutical or chemical laboratories) IN THE PHARMACY DEPARTMENT—The Registrar, The University, Nottingham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Russian Comfrey Report No. 1: The 1954 Research Results. By Lawrence D. Hills. Pp. ii+36+5 plates. (Braintree: Henry Doubleday Research Association, 1955.) 3*s*. [153

British Institute of Management. The Recruitment and Training of Men Intended for Management Positions. Pp. 70. (London: British Institute of Management, 1955.) 5*s*. [153

Pitt Rivers Museum: University of Oxford. Hair Embroidery in Siberia and North America. By Geoffrey Turner. (Occasional Papers on Technology—7. Edited by T. K. Penniman and B. M. Blackwood.) Pp. 83+16 plates. (Oxford: Pitt Rivers Museum, University of Oxford, 1955.) 15*s*. [153

Annual Report of the National Oceanographic Council, 1 April 1953—31 March 1954. Pp. v+28. (Cambridge: At the University Press, 1955.) 5*s*. net. [153

Institution of the Rubber Industry. Annual Report on the Progress of Rubber Technology. Vol. 18: 1954. Pp. ix+186. (Cambridge: W. Heffer and Sons, Ltd., 1955. Published for the Institution of the Rubber Industry.) 21*s*. [153

Metropolitan Water Board. Report on the Results of the Bacteriological, Chemical and Biological Examination of the London Waters for the years 1947–1952. By Lt.-Col. E. F. W. Mackenzie. (Thirty-fifth Report.) Pp. 116+2 plates. (London: Staples Press, Ltd., 1955.) 15*s*. 6*d*. [153

Proceedings of the University of Durham Philosophical Society. Vol. 12, No. 4: Observations on the Vascular Plants of the Outer Hebrides made in 1954. By Dr. J. W. Heslop Harrison. Pp. 29–34. Vol. 12, No. 5: Further Investigations in the Flora of the Magnesian Limestone Area of Durham. By Dr. J. W. Heslop Harrison and J. A. Richardson. Pp. 35–42. (Durham: University of Durham Philosophical Society, 1954.) [183

Proceedings of the British Weed Control Conference 1954, Hotel Majestic, Harrogate, November 2nd, 3rd, and 4th, 1954. Pp. x+624. (London: Association of British Insecticide Manufacturers, 86 Strand, 1955.) 30*s*. [233

Aero Research Technical Notes. Bulletin No. 146 (February, 1955): "Redux" and the *Comet* Enquiry. Pp. 3. (Duxford: Aero Research Limited, 1955.) [233

Scientific Journal of the Royal College of Science—Vol. 24, containing papers read before the Imperial College Chemical Society; the Royal College of Science Natural History Society; the Royal College of Science Mathematical and Physical Society. Pp. vi+122. (London: Royal College of Science, 1954.) 10*s*. 6*d*. [233

Department of Scientific and Industrial Research. Road Research Laboratory. Road Research Technical Paper No. 34: Testing Concrete by an Ultrasonic Pulse Technique. By Dr. R. Jones and E. N. Gatfield. Pp. vi+48+2 plates. (London: H.M. Stationery Office, 1955.) 2*s*. 6*d*. net. [233

Southern Regional Council for Further Education. Sandwich Training and Education—Report on addresses by Sir Arthur J. G. Smout, and Mr. J. Wilson, 14th October, 1954, at the Conference Room, Civic Centre, Southampton. Pp. 15. (Reading: Southern Regional Council for Further Education, 1954.) [233

Royal Institute of Chemistry. Annual Report of the Council for 1954. Pp. 28. (London: Royal Institute of Chemistry, 1955.) [233

Observations made at the Royal Observatory, Greenwich, in the year 1941, in Astronomy, Magnetism and Meteorology, under the direction of Sir Harold Spencer Jones. Pp. vi+258. (London: H.M. Stationery Office, 1954.) 70*s*. net. [233

Ministry of Agriculture and Fisheries. Memoirs of the Soil Survey of Great Britain. England and Wales. The Soils of the Glastonbury District of Somerset (Sheet 296). By B. W. Avery. Pp. iv+131+4 plates. (London: H.M. Stationery Office, 1955.) 15*s*. net. [253

William Ramsay Centenary Appeal: the Report of the Trustees, 1955. Pp. 23. (London: University College, London, 1955.) [253

Oundle School Natural History Society. Annual Report, 1954. Pp. ii+64. (Oundle: Oundle School Natural History Society, 1955.) [253

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 932, Vol. 247 (24 March 1955): The Structure of Some Proteins as Revealed by an X-ray Scattering Method. By U. W. Arndt and D. P. Riley. Pp. 409–439. 10*s*. No. 933, Vol. 247 (24 March 1955): The Thermal Conductivity of Metals at Low Temperatures. By H. M. Rosenberg. Pp. 441–497. 18*s*. (London: Royal Society, 1955.) [253

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 1, Vol. 5, No. 8: Movements of Salmon off the North-East Coast of England. By W. G. Hartley and J. D. Brayshaw. Pp. 17. (London: H.M. Stationery Office, 1955.) 3*s*. 6*d*. net. [293

Anti-Locust Research Centre. Anti-Locust Bulletin No. 19: A Laboratory Study of Roosting Behaviour in Hoppers of the African Migratory Locust (*Locusta migratoria migratoriodes* R & F). By Dr. R. F. Chapman. Pp. ii+40. (London: Anti-Locust Research Centre, c/o British Museum (Natural History), 1955.) 4*s*. 6*d*. [293

Macaulay Institute for Soil Research. Annual Report, 1953–1954. Pp. 55+2 plates. (Craigiebuckler, Aberdeen: Macaulay Institute for Soil Research, 1955.) [293

City and Guilds of London Institute. Annual Report of the Council, 1st October, 1953, to 30th September, 1954. Pp. 47+xvii. (London: City and Guilds of London Institute, 1955.) [293

Veterinary Clinical Studies at Cambridge. By Prof. L. P. Pugh. (Inaugural Lecture given at Cambridge, 8 March 1955.) Pp. 1+26. (Cambridge: At the University Press, 1955.) 2*s*. 6*d*. [293

Everest: A Guide to the Climb. (Chart.) By James Champion. (London: University of London Press, 1955.) 1*s*. 6*d*. [313

Scottish Marine Biological Association. Collected Reprints, 1954 (Nos. 148–184). (Millport, Isle of Cumbrae: Scottish Marine Biological Association, 1955.) [313

British Journal Photographic Almanac, 1955. (Ninety-sixth year of publication.) Edited by Arthur J. Dalladay. Pp. 1+640+32 plates. (London: Henry Greenwood and Co., 1955.) 5*s*. net (Linson board covers); 7*s*. 6*d*. net (Cloth bound). [313

The Year's Photography, 1955. (Reviews of Photographical Art, Photographic Science and Applied Photography, with a Selection of Pictures from the Exhibitions held in the Society's House during the past year.) Pp. 19+82 plates+xii. (London: Royal Photographic Society, 1955.) 7*s*. 6*d*. [313

Wool Industries Research Association. Report of the Director of Research for 1954–55. (W.I.R.A. Publication No. 201.) Pp. 31. (Leeds: Wool Industries Research Association, 1955.) [313

Other Countries

Mitteilungen des Deutschen Wetterdienstes. No. 10 (February 1955): Die Synoptiker-Tagung in Frankfurt a.M. vom 1. bis 4. November 1954. Pp. 118. (Bad Kissingen: Deutschen Wetterdienstes, 1955.) [183

Administration Report of the Government Museum, Madras; the National Art Gallery, Madras; the Government Museum, Pudukkottai; and the Connemara Public Library (Exchange Section), Madras, for 1953–54. Pp. 38+2 plates. (Madras: Government Press, 1954.) [183

Federation of Nigeria. Annual Report of the Department of Agriculture (Central) for the year 1952–53. Part 1: Pp. 15. 9*d*. net. Part 2: Pp. 47. 9*d*. net. (Lagos: Federal Government Press; London: Crown Agents for Oversea Governments and Administrations, 1955.) [183

Council of Scientific and Industrial Research, New Delhi. Engineering Research in India. By V. Cadambe. Pp. x+114. (New Delhi: Council of Scientific and Industrial Research, 1954.) [183

Colony and Protectorate of Kenya. Report of the Forest Department for the years 1951, 1952, 1953. Pp. ii+71. (Nairobi: Government Printer, 1954.) 8*s*. 4. [223

Seventh Annual Report of the Pacific Marine Fisheries Commission for the year 1954. Pp. 20. (Portland, Oregon: Pacific Marine Fisheries Commission, 1955.) [223

International Scientific Radio Union. Special Report No. 4: The Distribution of Radio Brightness on the Solar Disk. Special Report No. 5: Interstellar Hydrogen. Pp. 72. (Brussels: International Scientific Radio Union, 1954.) [223

Canada. Department of Agriculture. Science Service—Division of Forest Biology. Forest Lepidoptera of Southern Ontario and Their Parasites Received and Reared at the Ottawa Forest Insect Survey Laboratory from 1937–1948. By Henri Raizenne. Pp. iv+238. (Ottawa: Department of Agriculture, 1952.) [233

Indian Central Jute Committee. Annual Report of the Jute Agricultural Research Institute (1953–54). Pp. 145. (Calcutta: Indian Central Jute Committee, 1955.) [253

Journal of Biophysical and Biochemical Cytology. Vol. 1, No. 1 (January 25, 1955). Published Bimonthly. Annual Subscription 7.50 dollars; Single issues 1.50 dollars. (Baltimore, Md.: Rockefeller Institute for Medical Research, 1955.) [253

Smithsonian Miscellaneous Collections. Vol. 128, No. 2: Washington, D.C. Precipitation of 1954 and 1955. By C. G. Abbot. Pp. 3. (Publication 4210.) (Washington, D.C.: Smithsonian Institution, 1955.) [253

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien, Band 5, Nr. 3: Maps of a Selection of Scandinavian Hieracium Species. By Gunnar Samuelsson. Edited by Erik Almqvist. Pp. 10+123 maps. (Stockholm: Almqvist and Wiksells Boktryckeri AB.; London: H. K. Lewis and Co., Ltd., 1954.) 26.50 kronor. [253

Československa Akademie Věd: Academia Scientiarum Bohemoslovenica. Folia Biologica. Tomus 1, Fasciculus 1 (February 1955). Pp. 64+8 plates. Yearly subscription (6 numbers) 60 Kčs. Single issues 10 Kčs. (Praha: Biologicky ústav ČSAV. Orders to "Artia," Smecky 30, Praha 2, 1955.) [293

Union of South Africa: Department of Education, Arts and Science. Report of the Archæological Survey of the Union of South Africa for the period 1st April, 1953, to 31st March, 1954. (Annual Report No. 19.) Pp. ii+5. (Pretoria: Government Printer, 1954.) [293

Joint Establishment for Nuclear Energy Research. Third Annual Report, 1953/54. Pp. iii+28. (Kjeller near Lillestrøm: Joint Establishment for Nuclear Energy Research, 1955.) [293

World Health Organization. Monograph Series No. 26: Poliomyelitis. Contributed by Robert Debré, Darline Duncan, John F. Enders, Matthieu-Jean Freyche, Sven Gard, James Gear, W. McD. Hammon, Hilary Koprowski, H. C. A. Lassen, Johannes Nielsen, John R. Paul, A. M.-M. Payne, A. J. Rhodes, W. Ritchie Russell, A. B. Sabin, Stéphane Thieffry and W. Wood. Pp. 408. (Geneva: World Health Organization; London: H.M. Stationery Office, 1955.) 24 Swiss francs; 40*s*.; 8 dollars. [313

New Zealand. Department of Scientific and Industrial Research—Geophysics Division. Amberley Observatory. Magnetic Results for 1952. Pp. iii+56. (Wellington: Government Printer, 1954.) [313

United States Department of Commerce: Weather Bureau. Technical Paper No. 15: Maximum Station Precipitation for 1, 2, 3, 6, 12 and 24 Hours. Part 10: New York. Pp. ii+113. (Washington) D.C.: Government Printing Office, 1954.) 60 cents. [313